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A Treatise on Paper.

Technological Series on Printing.

A TREATISE ON PAPER

WITH AN

OUTLINE OF ITS MANUFACTURE, COMPLETE TABLES OF SIZES, ETC.

FOR PRINTERS AND STATIONERS.

BY RICHARD PARKINSON,

CERTIFICATED TEACHER (UNDER THE CITY AND GUILDS OF LONDON) AT THE HARRIS INSTITUTE, PRESTON, AND LATE OF THE MANCHESTER TECHNICAL SCHOOL; HOLDER OF CERTIFICATES IN "PRINTING,"—FIRST CLASS HONOURS WITH FIRST PRIZE SILVER MEDAL AND £5), 1882; "OILS, COLOURS, AND VARNISHES," 1884; AND "PAPER MANUFACTURE," 1885.

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PREFACE.

In 1879, the Council of the City and Guilds of London Institute for the Advancement of Technical Education included in their Programme for the first time, a Syllabus in "Printing."

The syllabus of the first years was very extensive; but it has been gradually reduced in its requirements, until it now more nearly represents the usual course in which an apprentice in a provincial office is given instruction. To a London-bred workman, whose knowledge of his profession is probably confined to one department, it still presents many points upon which he will necessarily be ignorant.

It is characteristic of this profession that, to be so completely versed as to be qualified for every position in it, a store of information is required which is almost without parallel for its extent in any other of the industries represented in the Programme. A provincial printer will generally admit that a more complete knowledge of the mysteries of roller composition, or printing inks; or of the manufacture of paper; or the arts of stereotyping and electrotyping, which are all distinct trades; would make him far more valuable as an all-round man. In fact, a printer is a consumer only, being dependent upon others for almost everything he needs; and unless he exerts himself to learn something of the manufacture of the materials brought to his hands, he must ever lack intelligence in his treatment of the difficulties in their use: and these are not a few.

In searching for information of that kind which he concluded would best serve the interests of the students who attended his classes, the writer was much impressed with the difficulties in his

way. The text books recommended at the end of the syllabus are either out of print, or treat the subject of Printing generally, or are in a foreign language; only two or three giving a detailed account of one department each. As a consequence, he found it necessary to make some study of the kindred and allied trades; his notes eventually accumulating until he was enabled to pass the examinations of the City and Guilds of London Institute in "Oils, Colours, and Varnishes," and "Paper Manufacture."

In deciding to add to the text books on the technology of Printing, the writer has elected to divide his labours over a series of volumes, rather than publish all his notes in one. In taking this course he has been influenced by several considerations. The information will be better within general reach. The venture of publication is not very great. All care can be concentrated upon one branch. And the information is diffused immediately after completion.

For much of the matter immediately connected with the manufacture of paper, the writer is indebted to general reading. Some other points, which are not so decidedly the property of the public, he has acknowledged the sources of; and here tenders his thanks for their use. But it is hoped that much will be found that is new, or is put in a new light.

To those firms who have so kindly lent him electros of their machinery, his thanks are also due. He is conscious that without their aid, his text would be but vaguely understood in some parts

Although he anticipates his critics by admitting that the work might have been done in a much better manner by others, yet he is desirous of pointing out that it has until now been left undone; and for the first time, an attempt has been made to gather into one volume, a knowledge of the qualities of paper derived from an insight into their manufacture.

50, St. George's Road,
Preston, 1886.

CONTENTS.

Section 1. Paper Manufacture.

CHAPTER I.

PAGE.

SELECTION OF THE MATERIALS 9

CHAPTER II.

CONVERTING THE MATERIAL INTO PULP 13

CHAPTER III.

PAPER MAKING BY HAND 21

CHAPTER IV.

PAPER MAKING BY MACHINE 26

Section 2. Characteristics of Paper.

CHAPTER I.

THE QUALITIES OF PAPER 31

CHAPTER II.

HAND-MADE *versus* MACHINE-MADE PAPERS . . . 39

CHAPTER III.

SIZING AND FINISHING 47

CHAPTER IV.

ON JUDGING PAPER, AND DISTINGUISHING MACHINE-MADE FROM HAND-MADE PAPERS . . . 56

CHAPTER V.

THE RIGHT AND WRONG SIDES OF PAPER 64

CHAPTER VI.

NAMES, SIZES, AND WEIGHTS, OF PAPER AND CARDS 66

CHAPTER VII.

MISCELLANEOUS 71

TREATISE ON PAPER.

Section 1.

PAPER MANUFACTURE.

CHAPTER I.

SELECTION OF THE MATERIALS.

1. A fibrous nature (which is the requisite in all material used as a basis for paper) is to be observed in most plants; and from the plant-world, the paper manufacturer of the present day acquires his stock. Plant-fibre is mostly amenable to the same system of bleaching, which is not the case with animal matter. Here is the sole reason for woollen and silk rags being picked out and rejected, as they invariably are, from other rags in a paper mill. They are not inferior in strength, or in the power of felting together in the fibre, but the course of bleaching for them must be a special one, quite distinct from that followed for the usual class of material—that having its origin in plant life. The same objection holds good for all matter of animal origin.

2. The sources of supply are also further limited by other considerations. Granted that a plant yields a fibre admirably suited

to the paper maker's purpose; yet, because (*a*) The species is not grown in sufficiency; or (*b*) The charges for transferring to the mill are high; (*c*) The room required for storing is inconveniently large; (*d*) The expense of converting it to pulp great; or (*e*) The yield of fibre incommensurate with the amount of trouble required for its conversion to that state: he must class it as unsuitable. He naturally accepts those materials which yield the greatest return for the least outlay, allowing for the difference in the quality of the stuff from each.

3. The materials used as fibre are rags, sail-cloth, esparto, wood, sack-cloth, coarse bags, ropes, tow, cotton waste, jute, Manilla hemp, megass, or "cane trash," the refuse of the stalk of the sugar cane, after the juice has been expressed; straw, flax, hemp, and cotton.

4. Rags are the finest materials the paper maker can obtain for his purpose. They make the best classes of paper, and by a fortunate coincidence, this is the only trade that can make any use of them. Since there is no other demand for these rags, their value is determined solely by the competition among the manufacturers for the quantity in the market.

5. This cannot be said of all unmanufactured material; it is not found that flax, hemp, or cotton in their raw state are made into paper in any considerable extent. Moreover, according to Hofmann, but two and a half pounds of good white linen are obtained from a hundred pounds of flax or hemp; hence the expense that would be involved by adopting the raw material for paper.

6. Linen rags are luxuries only indulged in for the best of stationery purposes,—hand-made papers, ledger, loan, and drawing papers. Bank-notes are made from cuttings of entirely new linen. This class of rags makes a strong, stiff, crackling paper.

7. "Linen fibre is, like cotton, tubular; but the walls of the tubes are somewhat thicker, and are jointed or notched, like a

cane or rush. The notches assist greatly in the adhesion of the fibres one to another. This fibre possesses the other valuable properties of length, strength, and flexibility, and the latter property is increased when the walls of the tubes are crushed together by the action of the beating engine. From this fibre a very strong compactly-felted paper is made; indeed, no better material than this can be had for the production of a first-class paper." *Arnot.*

8. Cotton rags, especially those partly worn, are made into printing paper, their softness and yielding nature making this paper especially suitable to print upon.*

9. "Cotton fibre is long and tubular, and has this peculiarity, that when dry the tubes collapse and twist on their axes, this property greatly assisting the adhesion of the particles in paper-making. In the process of dyeing cotton, the colouring matter is absorbed into the tubes, and is, as will be readily appreciated, difficult of removal therefrom. Papers made exclusively of cotton fibre are strong and flexible, but have a certain sponginess about them which papers from linen fibre do not possess." *Arnot.*

* Since this was put in type, the writer has been favoured with a copy of a series of Papers read by J. W. Wyatt, Esq., Assoc. M. Inst. C.E., before the Institution of Civil Engineers, and he extracts from them the following:—"Cotton fibre is a development of "the parenchymatous tissue, which is the weakest among the elementary organs of a "plant, while the linen fibre is a development of the woody tissue, which is the strongest "of such organs. It is, therefore, generally considered that linen only should be used for "making the strongest and firmest paper. This may be the case as regards the spinning-"fibre, but experience proves that it is by no means the rule in dealing with the bruised "fibre for paper-making. With long and careful manipulation in the pulping-"engines, taking precautions to draw the fibre and not to cut it, new cotton will give a "stronger and much closer paper than new linen. The linen fibre, under the beating-"rolls, absorbs water more readily than the cotton fibre, and works up into a more "'greasy' and wet state necessary for a stiff, firm sheet of finished paper, but it does not "with that necessarily develop strength.

"After numerous trials to obtain a strong machine-made paper, at which the "Author was present, the strongest was produced with new cotton intimately mixed with "about one-fifth or one-sixth of its bulk of new linen."

10. "Ropes, coarse bags, and such like, are made from hemp, the cellulose or fibre of which is not unlike that of flax, only it is of a stronger, coarser nature.

11. "Manilla* yields the strongest of all fibres.

12. "Jute, which is the fibre, or inside bark, of an Indian plant, yields a strong fibre,† but is very difficult to bleach white." *Arnot.*

13. Esparto is a grass grown in Spain and in Africa. It is in appearance very similar to our common rushes. The yield of fibre reaches 46 per cent. of the bulk.

14. "Esparto fibre, which is now so extensively used, holds an intermediate place between the foregoing fibres and those of wood and straw." *Arnot.*

15. Wood is prepared as a pulp by two processes:—mechanical and chemical. To prepare it mechanically, a large piece of wood is pressed against the roughened face of a revolving grindstone, by which means splinters are torn off. In the chemical method it is boiled with caustic soda and bleaching powder; washed, and again treated with caustic soda. By the combined action it is converted into pulp.

Of itself, wood does not generally yield a strong fibre, and paper containing it in a large proportion, breaks readily on folding. *(See Specimen 1).*

16. From straw a strong paper is made, having a harsh and brittle feel. As at present treated in a paper mill it is a somewhat unsatisfactory material, producing only 37 per cent of fibre. This is accounted for by the strong alkalies which are used in order to dissolve the silicious coating on the straw: the fibre is partly sacrificed, passing into solution along with the silica.

* Manilla Hemp. R.P.

† When first imported, it was reported upon as being "not hemp, but a species of flax superior in quality to any known in the trade." R.P.

CHAPTER II.

CONVERTING THE MATERIAL INTO PULP.

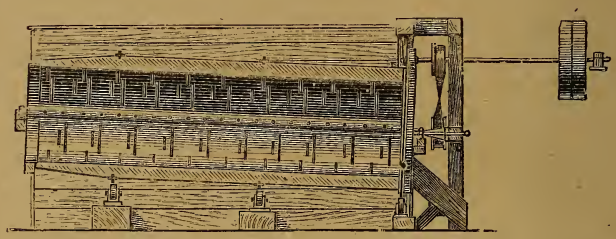
17. Sorting is the first process to which the rags are subjected on entering the paper mill, unless, as is not unusual, they are thrashed by a dusting machine, to free from dirt as much as possible. Linen rags are to be separated from cotton; and each again divided into sub-classes. When separated to the utmost extent, there are about twenty kinds of rags, for each of which the paper maker has a distinguishing name and mark. A printer need not be troubled with these marks, since they are quite without interest to him.

18. The sorting is performed by women, who pass the rags into the receptacles intended to hold each kind. At the same time, buttons are cut off; and pieces of wire, hoop iron, and all such substances as are used in the making-up of ladies' clothing, etc., are cut out. They open seams, and cut the large rags into small pieces. For her requirements each woman is provided with a table, into the top of which is secured a coarse wire netting, and a strong fixed knife, placed obliquely. Much of the dirt is loosened from the rags here, and is disposed of by the netting into a box beneath the table. That is the function of the netting.

19. A further and more vigorous purification from dirt is now attained by a machine termed the duster. It shakes dust loose,

and this falls through a wire netting. But a more general method is by the willow. This machine dusts the rags, and at the same time cuts them into pieces of a more uniform size.

20. The willow takes many special forms, but the general one is that of a large cone-shaped horizontal cylinder. Projecting towards the centre are short iron spikes, fastened on the inside.



ONE FORM OF RAG DUSTING MACHINE, OR WILLOW.

By the courtesy of Messrs. Bryan Donkin & Co., Bermondsey, London.

This cylinder revolves, and contains a second cylinder, of a skeleton form, which also has knives, or spikes, and revolves in the opposite direction to the outer one. Since the latter knives are fastened to the *exterior* of the cylinder, the combined effect of the two sets on the rags coming between them is as that of scissors.

21. The conical shape of the cylinders causes the rags to travel from one end to the other. Arriving at the end of the cylinder, they are ejected, and thrown into a further cylinder of wire. Through here the dust falls, and they arrive at the end of this cylinder in a tolerably clean condition.

22. They have now to be boiled. And to prevent needless repetition, it may be here stated that all stock except wood-pulp is boiled, though in different ways.

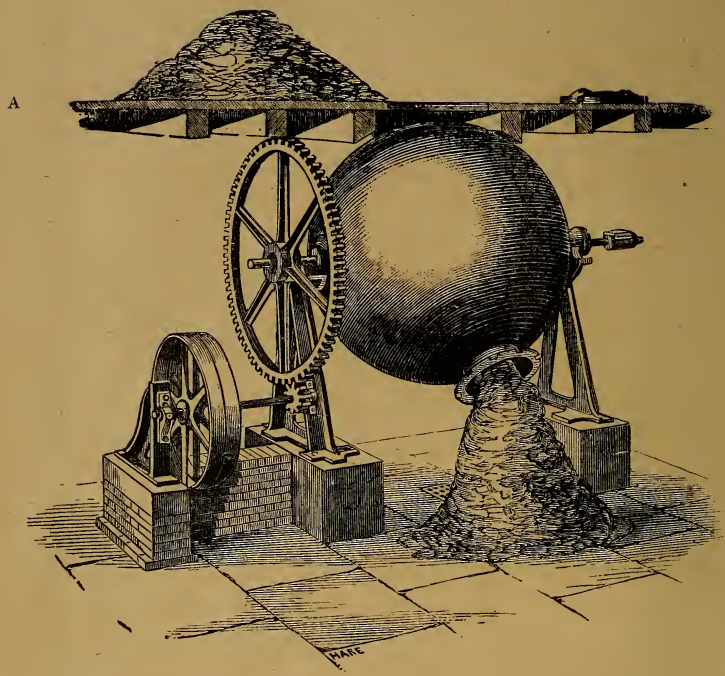
23. The dusting, sorting, etc., usually takes place in the storey above that which contains the boilers, so that the rags can

be dropped into them through a trap door in the floor, as shown along the section A B in the next cut.

24. Boiling has not for its sole object the removal of mere dirt. The fibre must be freed from the sizing and colouring matter in the linen and the cotton. The gummy, or resinous matter, taken up naturally in the growth of plants must be removed; and with it, fatty substances derived in the same way; while from straw must be dissolved the shining coat of silica, which is but another name for sand. *(Par. 84).* These substances are, like printing ink and paint, insoluble in water, and alkaline chemicals similar to those resorted to for cleaning formes are used for removing them. Caustic soda and caustic lime are the chemicals usually selected. They combine chemically with these fats and resins, sizing and silicious matters, and form soap It is well known that soap can be dissolved in water, and this is precisely how these foreign matters are got rid of: they are converted into soap on sufficient boiling with the alkalies, soda and lime, and that soap runs off along with the water in which it is dissolved. In some instances the alkalies act by dissolving the glutinous and other matters; or these may be decomposed by the agency of the alkalies; but the different actions are unimportant to printers and stationers.

25. Immense boilers are used. They are of two kinds:—rotating and stationary. Stationary boilers are used for material that does not require energetic measures to induce it to give up its impurities; while revolving boilers are used for rags, which are thus kept constantly moving, and in contact with fresh quantities of the alkaline liquor. The length of time required for boiling is from seven to twelve hours; varying with the nature, and consequently the requirements of the stuff.

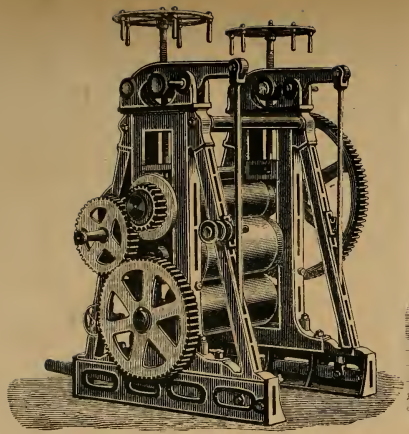
The illustration is of a boiler to hold about 25 cwt. of rags. Its sphericity adds greatly to its strength, and on the removal of the cover, enables the rags to fall out automatically while the boiler is revolving.



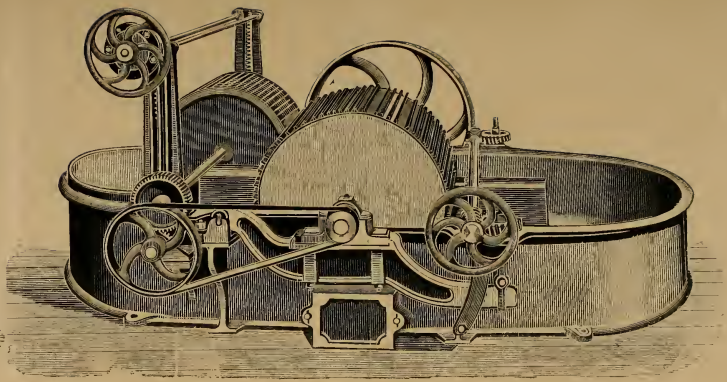
SPHERICAL ROTARY VOMITING RAG BOILER.
By the courtesy of Messrs. Bryan Donkin & Co., Bermondsey, London.

26. The washing of the rags or other material to free from the alkaline and dirty water of the boilers is the next process. Great oblong tanks, with round ends, and of varying capacity, are exclusively used. They are termed washing and breaking engines. The term *engines* applied in this sense is to printers a peculiar one, and it should be remembered, as it is frequently used.

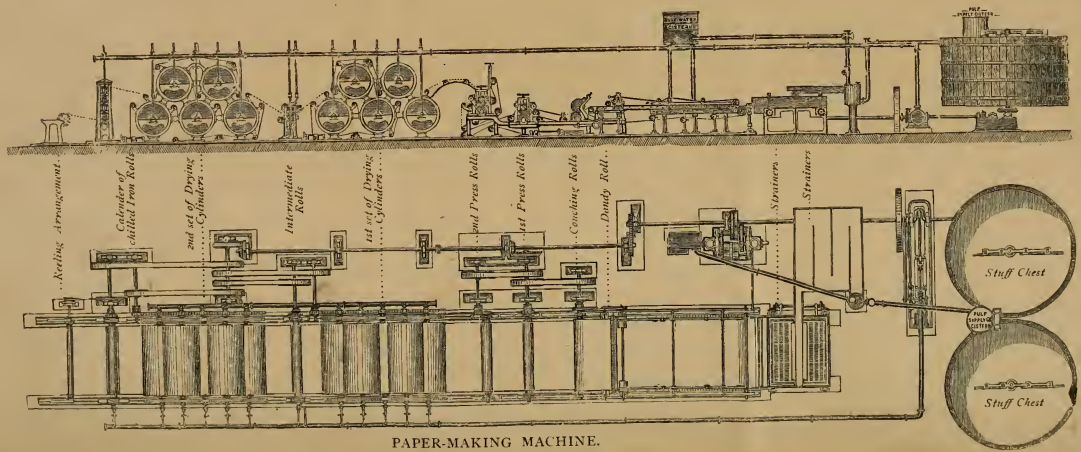
27. At one part of the bottom of the engine, upright knives are fixed ; over them revolves a drum, its exterior studded with knives which correspond with those which are stationary. By its revolving action, the material is moved slowly round the engine, drawn under the drum, between the knives, and hacked to shreds.



FRICTION GLAZING CALENDER.
By the courtesy of Messrs. Bentley and Jackson, of Bury.



WASHING AND BREAKING ENGINE.
By the courtesy of Messrs. Bentley and Jackson, of Bury.

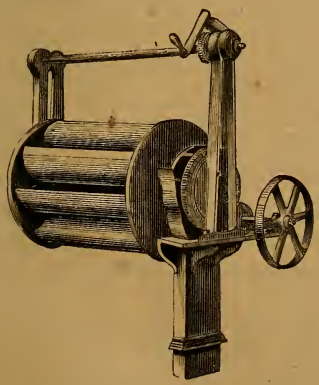


PAPER-MAKING MACHINE.
By the courtesy of Messrs. Bentley and Jackson, of Bury.

WASHING AND BREAKING ENGINE, AND BEATER.

By the courtesy of Messrs. Bryan Donkin & Co., Bermondsey, London.
Another view of an engine is given on the folding inset.

28. On another shaft, and at the opposite side of the engine, is another drum, called a drum washer,—a skeleton arrangement covered with wire gauze too fine to permit the fibrous stuff getting through. A portion of it is submerged, and dirty water enters through the gauze, is caught up by buckets inside (resembling those on a water wheel), lifted to a trough, into which it is emptied, and by it conducted away. Fresh clean water enters by the pipe at the end of the washing engine. When all the dirty water has been removed, the drum washer is raised, and the cutting alone continues; the rotating knives being



INTERIOR OF DRUM WASHER.

By the courtesy of B. Donkin & Co.

gradually lowered, in order to cut still finer as the stuff is reduced.

29. While the stuff is still in the breaking engine, the bleaching agent is added.

30. Bleaching is conducted by means of bleaching powder, which is dissolved and added to the pulp. When the pulp is thoroughly saturated with the bleaching liquid, the engine is emptied by means of valves, and the whole runs into great chambers having perforated zinc floors. Here it drains 24 hours or so to get rid of the bleach; and to aid in this, the pulp is pressed.

31. In the mill, and at the same time, there are tanks containing bleached pulp of various kinds—rags, wood, esparto, straw, etc. From these sources the manager directs what weights shall be taken, which is done, and the stuff put into wagons, for which miniature tramways are laid down in this part of the mill. This mixture is to make paper. It is emptied into beating engines to be more finely divided, sized, coloured, loaded, and to receive its last attentions previous to conversion into paper.

32. These beating engines are very similar to the washing and breaking engines; but the meshes in the drum washer are finer, and the knives more numerous and more rapid in their revolutions. The differences exist because the pulp is here to be cut up to a finer degree than in the washer and breaker, where it was termed "half-stuff."

33. In this engine, the washing is for the purpose of cleansing from chlorine, hydrochloric acid, calcic chloride, and other possible products resulting from bleaching. Finally, the last traces are neutralised by hyposulphite of soda, called in the mill, antichlor.

34. Being neutralised, which fact is tested by litmus papers, the pulp is ready for the loading material.

35. China clay (or kaolin), pearl white (or pearl hardening, or precipitated calcium sulphate), and barytes are generally used for weighting the paper. Used in this sense they are undoubtedly

adulterants. But they also improve the appearance by giving whiteness, and in readily receiving a good finish from the glazing calenders. They also fill up the pores, and enable the pulp to take up the sizing more effectually. China clay is the best of these materials for two or three reasons. It is more adhesive because of its rough exterior surface. Its specific gravity is not so high that it is liable to fall through the pulp to the under side of the paper while on the wire cloth and subject to the exhaust boxes.

36. The sizing matter goes in just after the clay. It may be gelatine, with resin dissolved in soda and boiling water, and called resinate of soda; or resin size prepared in the same way, but without the gelatine; or a starch size may be used. Sizing is discussed in a chapter specially devoted to it.

37. The circumstance of colouring reminds the reader of a laundress adding powdered blue to linen in order to make it appear white. *(Par. 144.)* This is how a paper maker treats the pulp. But in addition, a little red is used to correct the lack of colour. For the better qualities of paper, ultramarine and cochineal are the pigments in use; but the commoner papers are tinted with aniline colours, while archil is used to some extent. Paper which it is intended shall be toned also has the requisite colouring matter added here. It may be orange mineral, yellow ochre, or some other of the pigments from iron.

38. For coloured papers also, the pulp is prepared here. The colouring agents are many, but would not be of interest to our readers.

39. Alum is the final contribution to paper. It has several properties. As in dyeing, it fixes the colour to the fibre, and some colours it brightens and improves. It precipitates the resin as a compound of resin and alumina, and this envelopes the pulp in such a completely effectual manner as could not be thought of if

the material were merely powdered and thrown in.* The resin size thus fastens the clay to the pulp. Alum helps to add fineness. Lends hardness to the paper; and partly for this reason is largely added to paper which is without size. When the pulp is in the stuff chest, alum is essential for keeping up an even distribution.

40. After the alum is added, the "stuff," now ready for manufacture, is transferred to the vat, if for hand-made papers; to the stuff chest, if it is to be made by machine.

* To gain some idea of the extreme fineness that attends division and precipitation by chemical means, the reader may add to a highly-diluted solution of nitrate of lead, one or two drops of a dilute solution of common salt.

CHAPTER III.

PAPER MAKING BY HAND.

41 It is a common supposition that only the fine linen rags find their way into hand-made papers; there would be no difficulty, however, in producing samples containing *straw*. Whether the magic of the name, hand-made, is intended to cover this departure, is not known; but one is apt to think that the prices obtained for these papers should be some guarantee that superior material only is used in their manufacture.

42. A description of the manufacture of paper by machinery would serve for hand-mades up to the point when the stuff chest is reached.

43. Formerly, the comminution of the rags was performed by washing them in water, and then leaving them in a heap to putrefy. By this treatment they became tender—frequently rotten – and were thrown into a strong wooden chest, into which wooden stamping rods shod with iron, were fitted. These rods had a vertical motion, and literally pounded the rags to pulp: and pulp of long fibre and the strongest of paper resulted. The beating engine *(par. 32)* supplanted these stampers. It was the invention of a Dutchman, and is known as the "Hollander" to this day.

44. The willow and duster, washing and breaking engine, and

the beating and bleaching engine, have now superseded the old process, which required the work of 40 pairs of stamps for 24 hours in order to produce one hundredweight of pulp. And the only essential difference between hand and machine-mades at this day is the difference between making sheets singly and permitting them to dry naturally; and making them in a web and drying artificially. The points of comparison between the two makes are treated of in Chap. II., Section 2; and the methods of distinguishing one from the other are also given in Chapter IV., Section 2, "On Judging Paper."

45. Slow, careful processes—nothing hurried: good material and accurate picking of it; efficient boiling and washing; careful breaking and slow beating (actions approximating to drawing out or rending the fibre, rather than cutting and mincing it): these give a fibre which makes the backbone of an ideal hand-made paper.

46. The vatman now takes this fibre or pulp in hand, to form from it sheets of paper.

47. The vat is a large tank of wood or stone, and wider at the top than the bottom, It is about 5ft. square and 4ft. deep. A steam-pipe is fitted into the vat, in order that the pulp and water may attain a certain temperature; and an agitator serves to keep the pulp and water uniformly mixed.

48. The mould on which paper is made consists of a frame of wood (of which there are various sizes, corresponding to the sizes of paper), neatly joined at the corners. Across the narrow way of the frame are ribs of wood, about an inch and a half apart, and laid flush with the top of the framework; running the long way are wires laid parallel to each other, 15 or 20 in an inch. To hold these wires in position, others are mounted upon them, over the wooden ribs, and to them the long wires are stitched by fine wire. All these wires, leaving their impression in the soft pulp, constitute the water-marked lines of a "laid" hand-made paper.

49. Standing at the vat, the vatman takes in his hand the mould, and lays upon it the deckle. This is also a wooden frame, and when laid upon the mould, they form together a shallow tray of wire. The deckle may be, and is for small sheets, divided by narrow ribs of wood, so that two or four sheets of paper can be made at once. Dipping together the mould and deckle into the vat, he brings up pulp in sufficiency to form a sheet of paper of such a weight as is required for the order he is engaged upon, and pours back the surplus. It will be perceived that this is a very delicate operation; for the vatman has nothing to guide him here except his own sense of feeling; but he has cultivated this sense to such a nicety that it is said of him that he can make sheet after sheet of the larger sized drawing papers with a variation of no more than a grain or two in the weight of any two of them. Moreover, unless the mould be held in a perfectly horizontal position during the felting and settling of the pulp, the sheet of paper will be thicker on one side than the other. He now shakes the mould; first, from his breast outwards, and back again; this is called the "fore-right shake." Holding, as he does, the mould so that the long parallel wires run from right to left hand, this shake takes place across the wires,— not along them. The second shake is from right to left, and back again. By these movements, the fibre* or pulp is propelled in four directions *(par. 96)*, which causes it to felt, or interweave itself completely; and at the same time, water is assisted to escape through the wire.

50. Pushing the mould and newly-formed sheet along a board

* The reader who has not had an opportunity of seeing the fibre in process of manufacture in a paper mill, may form a tolerable idea of its appearance by examining the surface of any of the mottled tinted papers in common use, the French greys. *(Specimen 2)*. It will be understood that the fibre varies in length. A striking contrast is shown in a comparison of this with a sheet of Japanese copying paper. *(Specimen 3)*. The length of fibre here is immense; and as a consequence, so is the strength of the paper compared with its weight. It is hand-made.

on his left, he removes the deckle, and uses it along with a duplicate mould to form another sheet.

51. The vatman's assistant, who is called the coucher, removes the mould and sheet, and turns it upside down upon a piece of woollen felt of a special make, to which the paper is transferred; and removing the mould, he covers the sheet with another piece of felt, and returns the mould to the vatman.

52. Six or eight quires of paper being thus made, with a piece of felt between each sheet, a pile 15 to 18in. high has been built up on a plank, by means of which the pile is transferred to a press, where it is subjected to a pressure of about 100 tons.

53. Being sufficiently compressed, the paper and felts are slid through the press, and on the other side, a boy, called a layer, takes charge of them, and dissects the pile by separating and laying the sheets and flannels in two heaps.

54. The felts are immediately returned to the coucher, and the paper goes under the press again, where it remains all night, the object being to impart surface, to obliterate the felt marks, and to get rid of more moisture.

55. On the following day it is again separated, built up again as a fresh pile, and pressed again in another press. The process is termed "separating," and is twice repeated for fine papers, in order to attain surface.

56. Two men and a boy make six to eight reams in a day.

57. To lift a sheet of antiquarian (53in × 31in.) from the vat, it is said that nine men and mechanical aid are required.

58. Drying is the next operation. The sheets are taken, four to eight at a time, and hung over ropes of cow hair—cow hair, because this does not stain the sheets—in a room which, in the oldest hand-made establishments, was known as the loft. Hence the term "loft-dried."

59. They are next sized by gelatine. *(Chap. III., Section 2).* After this process they are again dried and pressed; sorted, and

the imperfect sheets thrown out, to be either sold as retree or returned to the beaterman for re-conversion; perfect sheets being counted into reams.

60. A careful consideration of the processes involved in this mode of manufacture will have led the reader to see that each is of a slow, laborious nature. It will remain for a separate chapter to show how this affects the quality.

61. The blue, whether ultramarine or smalts, added to the pulp for the purpose of colouring, tends to fall to the bottom of the vat by reason of its high specific gravity. From this it is prevented by the hog or agitator; but when the pulp is formed into paper nothing prevents it, and so one side of a sheet of yellow, azure *(par. 76)*, or blue hand-made is usually bluer on one side than on the other. In stationery books the differently coloured pages would fall opposite to each other and present an unsightly contrast, as may be seen by opening a quire of these papers at any place other than the centre. In well finished books the sheets should be turned alternately, so that the two shades are separated, and fall in pairs. *(Specimen 4.)*

CHAPTER IV.

PAPER MAKING BY MACHINE.

A DIGRESSION was made after accompanying the pulp in its manufacture up to the stuff chest, in order to describe the method of making paper by hand.

62. The stuff chest is a large wooden vat, having a varying capacity for perhaps 1000 or 1200 lbs. of stuff. The chests are made cylindrical in shape, in order that there may be no corners where the stuff can lodge. This precaution is but one of many between here and the paper machine for arresting all pieces of insufficiently-beaten material, knotted pulp, pieces of string, sand, buttons, and anything that may have escaped conversion by previous processes. Designed for this purpose are traps, in which sand effects a lodgment by reason of its high specific gravity; and gratings, through which the pulp is forced, and which serve to retain pieces of string and unbeaten rags. Down the centre of

the stuff chest is a vertical wooden shaft, and arranged upon this at intervals, and at right angles to it, are wooden arms. Movement being imparted to the shaft, the arms rotate in the stuff, keeping the pulp and water thoroughly mixed, and preventing the pulp from subsiding to the bottom of the chest.

63. The dilution of the pulp is a very important matter. By various methods, a constant unvarying charge of pulp and water must be delivered to the machine at every stroke of a pump made for the purpose. If, then, the amount of water present should vary, naturally, the supply of pulp must vary, and paper thicker or thinner than that which it was intended to make will be the result.

64. Having passed the revolving strainers, gratings, and the other necessary adjuncts to paper making, the pulp is now at the machine.

65. The means by which the flow of pulp is regulated may be compared to an ink-duct. A "doctor" blade, made with a knife-edge of steel, is adjustable, and permits more or less pulp to flow through.

66. A flat apron, frequently of leather, receives the pulp (which closely resembles soapy water, from its degree of dilution). This apron is the connecting link between the duct and the wire web of the machine.

67. The wire cloth resembles the blanket in a ruling machine in its manner of working. It is endless, and is kept stretched by rollers at each extremity. The material is woven wire, having something like 40 to 80 meshes per square inch. According to the fineness of the paper being manufactured, one cloth is substituted for another, which is finer or coarser.

68. As the wire travels it receives a regular shaking motion in a direction at right angles to the direction in which it is moving. This is known as the "side shake," and, as eventually shown, is an important factor in the distribution of the pulp. At present,

it will be sufficient to speak of it as assisting to retain the water in the stuff during the settling of the fibre in the required direction. The shake is imparted at this end of the machine, where its effect is, of course, greatest, gradually decreasing until the couching rolls are reached.

The distance over which the pulp travels while in the company of the wire cloth, is about six yards.

69. The width of the paper in the course of manufacture is regulated by means of deckle straps. These are of india-rubber, and travel at the same rate as the wire-cloth, and in contact with it. They stand higher than the pulp, their purpose being to keep it within bounds.

70. Two vacuum boxes are placed under the wire cloth, and these draw away any water that has failed to escape naturally.

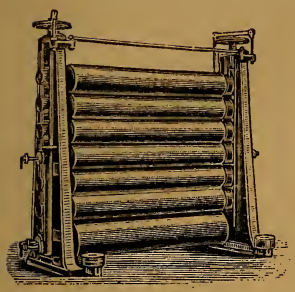
71. The pulp has now become paper, but of a very wet and tender description; and while in this state, and necessarily very susceptible, the watermark is imparted by the dandy roll. Of this too, there is much to say; but its discussion is deferred to par. 81, where its use can be shown more clearly.

72. From here the web travels unsupported a short distance, having left the wire, and then meets the couching rolls. These are a pair of rollers working in unison, and covered with felt. Their purpose is similar to that in the couching of hand-mades, compressing the material just sufficiently to lay and consolidate it, and remove water.

73. The press rolls of cast iron, now take the paper, and impart a little finish.

74. After these come a long series of large iron cylinders for drying purposes. They may be sixteen or more in number, and are heated; the last more intensely than the first, so that the web of paper passing between and round them receives an ever-increasing degree of heat.

75. Finally, come the glazing cylinders; a stack of massive iron rolls, having their axes parallel to each other, and in the same vertical line. The pressure of these rolls can be adjusted. The paper threads through the stack, from top to bottom, or from bottom to top, and thus receives its finish, or surface. Should it require anything further than that given to good printings, other means are adopted. These are discussed in the 106th and some of the following paragraphs.



CHILLED IRON ROLLS.
By the courtesy of Messrs. Bentley and Jackson, of Bury.

With this, the section on matters pertaining strictly to the manufacture ends.

Accordingly as the paper is for use on web or on jobbing machines, it is now cut up, or it is re-wound into solid reels.

Section 2.

THE CHARACTERISTICS OF PAPER.

CHAPTER I.

THE QUALITIES OF PAPER.

76. Paper may be divided into four classes:—*(a)* writings, including loan and account book papers, *(b)* printings, *(c)* unsized, *(d)* wrapping. The first three only will find place in this work.

(a) Writings.	*(b)* Printings.	*(c)* Unsized, or absorptive.
Cream Wove.	Laid.	Blotting.
Cream Laid.	Wove.	Filtering.
Yellow Wove.		Plate Paper.
Azure Laid.		Some Printings.
Blue Wove.		India Proof.
Blue Laid.		Copying.
Tinted Papers.		Tissue.

"Azure laid" and "yellow wove" *(specimens 4 and 5)* are technical terms for laid and wove papers which may be, and frequently are, of precisely the same shade,—something between

blue and cream; the laid is always known as "azure," and the wove as "yellow." A "yellow laid" or an "azure wove" would be misnomers.

77. Drawing papers are included under the head of writings, since they are identical with these in names and sizes, with the exception of two or three of the larger ones. Drawing papers are always wove.

78. Except in names and sizes, there is no essential difference between writing and printing papers. *(a)* The prices of the two are very similar through all qualities; *(b)* The quality of the material may be the same; indeed, printings often contain fibre of a much better class than many of the lower-priced writings; *(c)* Many writings are resin-sized; so are printings; *(d)* The better classes of each are made on a finely-woven wire; *(e)* They may both be hand-made or both machine-made; *(f)* Either kind can be finished, or surfaced, to any extent; *(g)* Both may be made as laid or wove. On a short consideration of these points of identity, it will be inferred that, if requisite, a writing and a printing paper might often be cut from the same web.

79. There is, in these days, absolutely no difference in laid and wove papers, except in name and watermark.

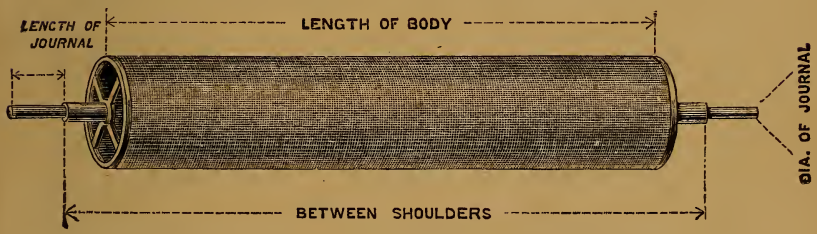
80. Paper manufactured by hand, it has been described, is made on a mould of wires. One kind of mould has these wires *laid parallel to each other*, about twenty to an inch, and bound in this position by fine wire to other and stronger wires which cross them at right angles. Paper from a mould of this description is called *laid (specimen 4)*, from the circumstance that the wires are *laid parallel*, not interwoven, with each other. The earliest papers were all of this description.

From the specimen of paper No. 2, it will be readily believed that the fine pulp of which it is composed could easily slip through the interstices between the wires, back into the vat. To use up any pulp that was too fine to remain in such a mould, it was

necessary to devise some other means; and so the wires were *woven together*, as in a fine hair sieve; hence the name *wove*. (*Specimens 2, 5, etc.*).

81. It has been shown that this was a device to use up short pulp; so that wove paper made by hand was inferior in quality to laid; for it must be remembered that long stuff yields the strongest papers. (*See footnote on page 23*). Because of this formerly important difference in the hand-mades,* it is not uncommon even now to hear an enquiry made for laid paper in preference to wove, on account of its imaginary superiority in strength.

To understand the full importance of the statement in paragraph 79, a more precise explanation of the dandy roll must be given here.



WOVE DANDY ROLL.

By the courtesy of Messrs. Bryan Donkin & Co., Bermondsey, London.

82. Since water-lines had their origin in the hand-moulds, the reader is referred back to paragraph 48 for a description of how they are imparted in hand-made book papers. Then conceive of the wire mould being bent round until it assumes a cylindrical form, and we have the dandy roll. If the surface of the dandy is

* The writer is assured by Messrs. Batchelor and Son, of Ford Mill, Ashford, Kent, that this statement is substantially correct, but that, as a matter of fact, the wove hand-mades, because of the uses to which they are put, are usually made of better material, *i.e.*, longer stuff, than the laid hand-mades.

formed of fine woven wire we get wove paper *(specimen 5)*; if of parallel and transverse wires, laid paper. *(Specimen 4)*. Either of them may have a distinguishing device, name, etc., stitched on

LAID DANDY ROLL.

By the courtesy of Mr. F. W. Potter, Hill Street, Barbican, London.

its surface. What it is necessary to clearly understand is that *all* paper manufactured by machine is formed upon a *woven wire cloth;* and that the characteristic waterlines have no part in deciding quality, since they are imparted by a dandy-roll riding lightly on the surface of the semi-fluid pulp. Further,—while the machine is running, and without making any alteration in the quality of the stuff sent down to the machine or in any other point, a laid dandy can be substituted for a wove dandy, or *vice versa.* A dandy roll has no purpose except that of making watermarks to suit purchasers.

83. Good white paper should possess no odour. See par. 133 on animal sizing, and tests for same.

84. The best papers, on burning, should leave a merely nominal amount of ash. The reasons for the addition of loading materials have been given in paragraph 35. But undoubtedly, in most cases the uses become abuses, by the addition of these clays, etc., in excess of actual benefit; in lieu of fibre; and for the sole purpose of weighting or loading the paper, and consequently, cheapening the production. Although it is not within the province of this book to discuss the wisdom of economy that prompts the reduction in quality by substituting clay for paper stock, which obviously adds no strength; yet it must be pointed out that the

consumer gets precisely what he pays for; and that possibly so long as low prices prevail, low qualities will accompany them.

The best papers, as hand-mades, and those made entirely from either linen or cotton, frequently do not yield more than five parts of ash to a thousand parts of paper. A certain proportion of ash is inevitable in any paper, not necessarily from the addition of clays, but because the linen or cotton, or other material of which paper is composed has assimilated in its growth certain constituents of the soil in which it grew.*

Common printings and news papers *(specimens No. 6 and 7)* contain as much as 25 per cent. of clay, and the proportions vary usually with the price at which the paper is sold. Butter paper contains clay in a wretchedly large proportion. A specimen is inserted, No. 8; also a specimen of cloth from which direction labels are made. It is a very coarse cloth loaded with clay, No. 9.

85. The method of determining the extent of adulteration is by taking a piece of the paper and ascertaining accurately its weight by means of delicate scales. This paper is reduced to small pieces by tearing, and placed in a small crucible of platinum. A blowpipe flame is directed upon the crucible to heat it to redness, and so burn to gas everything that is combustible. Thus nothing is left but the ash, and this, being mineral matter, is inconvertible. It is weighed with the same exactitude that was

* For a complete understanding of this assimilation of soil, and consequent nominal ash in paper; the reader is referred to the laws of the rotation of crops. Briefly, some plants extract one kind of matter from the soil, and others extract another kind. In the course of changing the crops, which course extends over three, four, or five years, the element which was lost to the soil in the first year through its assimilation by, say, corn, is eventually replenished during the ensuing three years by the disintegration of more rocks; when, this having been accomplished, corn may be grown again; and so with the other crops; each extracting that element which is left by those preceding it. The cotton plant yields on incineration, 7·8 per cent. of ash, which has been taken from the soil. Straw from wheat, etc., contains a deal of ash (silica), which imparts a brittle feel to paper. *(Par. 16).*

observed in weighing the paper, and the proportion of ash to fibre ascertained.

For amateur purposes, the samples may be pushed into a long piece of hard glass tubing, and this heated in the gas flame (preferably a Bunsen flame) until all gases have ceased to issue from the ends of the tube; this indicates that complete combustion has been successfully performed, and the ash may now be weighed. The per centage of ash is determined by the Rule of Three.

Example:—5 drachms of paper are burnt, and yield 1 drachm of ash.
Then 5 : 100 : : 1 : 20.

That is, 20 per cent. of clay, or some such substance, has been added.

86. Large quantities of clay require correspondingly large quantities of size to cement it to the fibre. Five to fifteen per cent. of clay may be added without the necessity for any accompaniment of size.

87. A curious effect of the presence of minerals in paper is sometimes noticeable in toned papers; one side of which is of a lighter tint than the other. The cause is similar to that described in paragraph 61, the loading material, by virtue of its greater specific gravity, falling to the lower side of the paper while it is travelling on the wire cloth.

88. When paper is digested with hot water, the resulting liquid should be neutral to test paper. The presence of unneutralised alkalies in the paper would cause the decomposition of iron salts in the water supplied to the mill, with the result of precipitating the iron as an oxide of that metal. Mr. Arnot says that one grain of dissolved iron in every gallon of water is prejudicial to the manufacture of a first-class paper. Some other and important actions of alkaline papers upon printing inks will be discussed under the heading of "Inks" in another of these treatises on the various branches of the profession of Printing. Paper giving an

acid re-action (shown by the action of its liquid on test paper), would act on the paper machinery by dissolving it, and upon inks, a description of which is reserved also. But in addition to these detrimental effects of acids and alkalies, both act injuriously on the paper by their effect on the fibre. The possible presence of these chemicals in the finished product is accounted for in paragraphs 30 and 33. Mr. Herring has recorded the singular fact that a ream of paper has been easily broken across the back of a chair through the effect of inefficient neutralising after bleaching.

89. Appearance, colour, finish, feel, all have some part in determining the value of any sample of paper such as is discussed in this work; but the most important factor is its strength.

90. The comparison of two samples of paper for strength is invariably made by determining the weight that each will bear without breaking. Certainly, in mills there are often more or less elaborate methods of ascertaining the breaking point, but they all have the same purpose in view. Cut pieces of paper about an inch in width from each sample, from the narrow and long way of the sheets; taking care that the slips are precisely the same in width. Secure each end to a rod having hooks attached. Hang one end from a rigid bar, and to the other end attach weights carefully until breakage occurs. A comparison of the weights which each will bear gives their comparative strengths.* The average of a number of experiments should be taken.

In a rougher way, the strength of paper may be judged by pulling it apart. The term *pulling apart* is used advisedly, since ordinary tearing does not accurately represent the idea to be conveyed. The two parts which are being torn asunder should be kept at the same level, or in the same plane. Of two papers,

The writer has had made a simple contrivance for finding the breaking weight. *See advt.*

the one which is torn with the greater difficulty is of course the stronger.

91. The strength of paper does not increase proportionally with its weight. So that of two papers which are sold as the same in quality, but are of different weights, neither would show a breaking point that could have been previously arrived at arithmetically from a prior knowledge of the strength of the other. The reason is, that as paper increases in weight, the length of its fibre must be reduced, by either longer or more severe treatment in the beating engine. If the stuff were sent to the machine long in fibre, the length of the wire cloth would scarcely suffice to get rid of the accompanying water, owing to the difficulty in the way of its percolation through the thickness of stuff.

92. Paper breaking on folding may do so from several causes. It may have been subjected to such a temperature on the drying cylinders that it has become practically scorched or brittle. An excess of loading material would cause a tender paper. The boiling, bleaching, or neutralising, may have acted too vigorously, until the fibre has suffered. A frequent cause of paper breaking when folded is the wood pulp, which enters largely into the composition of many modern papers. The specimen No. 1 consists entirely of wood pulp. Its tenderness may be proved by folding.

CHAPTER II.

HAND-MADE *versus* MACHINE-MADE PAPERS.

93. A few years ago, some attempt was made to settle the question of priority of excellence in papers made in a mould by hand, and those made in a continuous web by machine. The arguments for and against each kind were put forward by gentlemen who are thoroughly practical, and conversant with paper in all its varieties and phases. Unfortunately, the enquiry terminated unsatisfactorily, nothing definite being agreed upon. Still, much was disclosed that was of an exceedingly interesting nature; and much was left to form a basis for thought and experiment in which anyone might engage, and bring forth conclusions in a totally independent manner.

94. The seemingly hopeless variance amongst those who ought to know, rendered the task of a somewhat delicate character, since the results were bound to be antagonistic to either one view or the other.

95. The question is upon the strengths of the two classes, and whether paper made by machine can be as well sized as that made by hand.

The arguments were carried on by correspondence through trade journals; and it is proposed to review these in preference to raising the matter independently, or introducing new questions.

96. To take the question of strength. A statement was made by Mr. Martin, that the superiority of hand-made papers lay in blending the fibre by the vatman's peculiar shake of the mould. The upholders of the hand-made cause contend that "the stuff is run and shaken four ways." *(Par. 49).* That machine-made paper gets a good shake one way only, viz., from side to side. In addition, much stress was laid on the circumstance that hand-made paper, being made in single sheets, and permitted to dry naturally, has opportunities afforded for the felting of the fibre by contraction that are not secured for paper made in the web. As evidence of this, a hand-made loan paper was mentioned by Mr. Herring, and he stated that this paper on drying, shrinks as much as an inch in a foot. He considers that a machine-made paper loses in strength in the direction of the length of the web; "and we have a comparatively loose and porous web, caused by the disintegration of the fibres during the persistent tension maintained throughout by the rotation of the machine." That, finally, if the Bank of England notes that are now made by hand were to be made by machine from the same quality of material, Mr. Martin says they would not be as strong by 20 per cent.

This was the case for the hand-made papers.

97. Mr. Geo. F. Busbridge, of the East Malling Mills, Kent, was alone in the pleading for machine-mades, and it is right to say that most of the following arguments have been suggested by his.

98. Referring back to the wet end of the paper machine, it is seen that the stuff, on being thrown on the wire, is copiously diluted with water. What is the state of affairs then? If the reader has stood by a stream of water and thrown into it pieces of wood or straw, he must have observed that they invariably take a position in which their length is coincident with the direction of the stream, so long as its course is a smooth one. This is precisely what the paper fibre does. If the reader again examines the

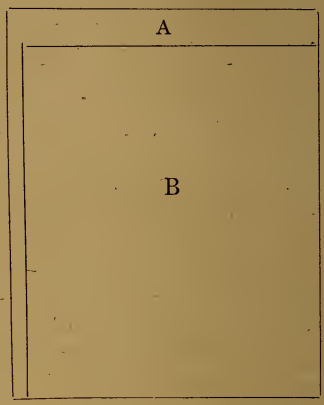
sheet of French grey *(specimen 2)*, he will become immediately conscious that the fibre on the printed side all lies with its length in the same direction. He is here assured that the length of the fibre has always lain in the direction of the length of the web.* While travelling along, the water in the pulp which is nearest the wire is naturally the first to escape, thus leaving these fibres fixed, and beyond the control of the side shake. As yet, the water diluting the higher strata of fibre has been unable to get away, and it is upon this fibre alone that the shake is directed with any advantage. Its effect is to partially counteract the running of the stuff, and the result is a compromise between this and the side shake,—an *upper layer* of stuff *distributed promiscuously* as regards its direction, immediately contiguous to an *under layer* of stuff *all laid in the same direction.* What is true for the granite, or mottled papers, is true for all others made by machine, whether white or coloured : the preponderance of the fibre lying one way, and thus, theoretically, a machine paper should be strongest in the direction of the length of the web. It is. By experiments it has been determined that it is 20 to 25 per cent. stronger in this direction than across the narrow way of the web ; the possibility of which was said in paragraph 96 to be precluded, owing to the persistent tension under which it is dried.

This point is disposed of finally in the tables of breaking points of papers *(par. 101)*.

99. There is no reason why equally good material should not be used for machine- as for hand-made paper. It may be boiled, washed, broken, beaten, and bleached with equally great care ; in short, as stated in paragraph 42, a description of the preparation of the materials for one class would serve for the other.

* This phenomenon can only be verified by mottled papers, since it is only in these that individual fibres can be distinguished.

100. That machine-made paper is denied the contraction on drying permitted to hand-mades, is incontrovertible. How does this affect the quality? Say that royal (24 in. × 19 in.) is being made at the vat, and let it be represented by the space A; it would, according to Mr. Herring, contract in drying to medium (22in. × 17½in.) represented by B. That is, if originally a 40lb. royal, it would dry to a 40lb. medium. There can be no difficulty in making a similar weight of paper by machine, simply giving out sufficient of fibre to form the required weight directly, in place of relying upon contraction for its production; for it would be obviously unjust to compare two sheets of the same weight but different in size. The question must be uninfluenced by the extent of shrinkage. What is to be determined is whether a given weight of fibre can be as well arranged to form a given size of sheet on a machine-wire as on a hand-mould.



101. The tables No. 1 and 2 represent the breaking points of hand- and machine-made papers of various makes, from tests made upon each way of the sheets.

The average breaking point of each column is determined by dividing the aggregate figures by the number of registered experiments.

$$\frac{36 \cdot 5}{15} = 2 \cdot 4 \quad \frac{40 \cdot 25}{15} = 2 \cdot 68 \quad \frac{68 \cdot 25}{18} = 3 \cdot 79 \quad \frac{51}{18} \; 2 \cdot 83$$

The comparisons are put in a per centage form.

Columns 1 and 2 show the relative strengths of the long and narrow way of hand-made sheets.

2·68 : 2·4 : : 100 : 89·55

TABLE 1.

A 14lb. Medium Loan Paper, in strips of 1in. wide.

HAND-MADE.		MACHINE-MADE.	
1 Length way of sheet.	2 Narrow way of sheet.	3 Length way of web.	4 Narrow way of web.
*2·5	2·75	3·75	3·5
2·5	3	3·5	3·25
2·5	2·5	4·75	3
2·25	3	3·5	2·5
2·25	3	3·25	2·5
2·5	2·75	4	2·75
2·75	2·75	4	2·5
2·75	2·75	4	2·75
2·75	2·5	4	2·5
2·5	2·75	3·75	2·75
2	2·25	3·75	3
2·5	2·75	3·75	3·25
2·5	2·75	3·75	2·75
2·25	2·25	3·75	3
2	2·5	3·5	2·5
		4	3
		3·75	2·75
		3·5	2·75
36·5	40·25	68·25	51

*The figures are not representative of weights, but are given as on the scale of the paper-breaking apparatus.

Columns 3 and 4 give the strengths of machine-made sheets tested each way.

3·79 : 2·83 : : 100 : 74·67

Columns 2 and 4 compare the strongest way of a hand-made sheet with the weakest way of the machine-made sheet.

2·83 : 2·68 : : 100 : 94·7.

Columns 2 and 3 compare the strongest ways of both hand- and machine-made sheets.

3·79 : 2·68 : : 100 : 70·71

TABLE 2.

A 40lb. hand-made royal drawing paper compared with a similar weight of machine-made drawing paper.

HAND-MADE.		MACHINE-MADE.	
1 Length way of sheet.	**2** Narrow way of sheet	**3** Length way of web.	**4** Narrow way of web.
5·5	5·75	7·25	5
4·75	5·5	7·5	5·25
4·75	4·75	7·75	5
6	4·75	7·5	5·5
4·5	6·25	8·75	5
4·5	4·75	8·25	4·75
4·5	5·25	7·5	4·75
4·25	6·25	7	5·25
5	6·25	7·5	5·5
43·75	49·5	69	46

Proceeding, as before, to get the average, the results are :—

$$\frac{43{\cdot}75}{9} = 4{\cdot}86 \quad \frac{49{\cdot}5}{9} = 5{\cdot}5 \quad \frac{69}{9} = 7{\cdot}6 \quad \frac{46}{9} = 5{\cdot}1$$

Comparison of columns 1 and 2 give

5·5 : 4·86 : : 100 : 88·36

Column 3 with 4,

7·6 : 5·1 :: 100 : 67·1

Column 2 with 4,

5·5 : 5·1 :: 100 : 92·7

Columns 2 and 3,

7·6 : 5·5 :: 100 : 72·37

102. The labour of obtaining and testing a sufficient number of specimens of equal weights in hand- and machine-made papers is very great. The tables selected for examples are two out of many that have been made for the sake of getting accurate results, and are given for the extreme figures they exhibit. As an average of the experiments, it may be stated that a hand-made sheet is from 5 to 10 per cent. stronger across its narrow way than in its length. That a machine-made is about 25 per cent. stronger in the direction of the length of the web than across it. That, given equal weights of machine- and hand-made sheets, the latter is about equal in strength in its weakest direction to the weakest way of a machine paper. And that a machine-made in its strongest direction exceeds in strength a hand-made in its strongest direction by about 20 per cent.

103. An arrangement that the writer understands is successfully at work in Messrs. Busbridge's mill, cuts the web while moist, and ensures the possibility of real loft drying in single sheets, so that this advantage, hitherto monopolised by the hand-mades, is now open to any class.

104. Another point of superiority in machine papers is their uniformity, which it will allowed can be rendered almost perfect. Notwithstanding the statement in paragraph 49 (for which the compiler is not responsible) there remains the fact that 25 per cent. of the total manufacture in a hand-made mill is sold as retree, because of inequality in weight and inefficient sizing.

105. A studious perusal of the commencement of the next chapter will do much to account for the difficulties in the way of

sizing both high class hand- and machine-made writings. In the case of the former there can be no resin size added advantageously, since the resin is never submitted to the temperature necessary to cause its fluidity. Therefore, it must devolve upon gelatine size to fill up the pores. This is accomplished in but an irregular manner, and consequently a hand-made sheet will not permit of deep erasures. A resin-sized sheet may have erasures made in it to any extent, since it is equally well-sized throughout its thickness. Add to this that it may be passed through a cistern of size after completing the circuit of the drying cylinders, and an animal sized surface is obtained. From here it may undergo slow artificial drying—a species of loft-drying. Such papers possess a thorough sizing throughout their bulk, but must be dried at a high temperature in order to attain the result; and when attained it is at the cost of the contraction in natural drying, which is possible by the method in paragraph 104.

CHAPTER III.

SIZING AND FINISHING.

PROBABLY there will be no more suitable place than this for stating that there is no connection between the sizing of paper and the surface imparted to it. A high finish is added with equal ease to sheets with and without size.

106. In order that a thorough comprehension of the functions of size may be obtained, the reader who is not already informed upon the subject, may write with pen and ink upon blotting and writing paper *(Specimens No. 11 and 12)*. While the writing paper receives the finest stroke of the pen without exaggerating it, the ink on the blotting paper spreads, or runs. The same characteristic is observable by trial in tissues *(specimen 13)*, copyings *(specimen 14)*, unsized printing *(specimen 15)*, plate paper *(specimen 16)*, Japanese **(specimen 3)*, Dutch hand-made *(specimen 17)*. Occasionally, a writing paper is met with that is unfit for its purpose, owing to the circumstance that the ink runs—spreads—shows through the paper. It is inefficiently sized.†

The difference between a sheet such as No. 11 and all those afterwards enumerated in that paragraph, is due to the presence of size in the former and the absence of it in the latter.

* It would be erroneous to assume that all Japanese papers possess this peculiarity; or that all have the flimsiness of the sample. Paper is imported from Japan in all weights and sizes, and fit for printing luxurious editions.

† The class of papers known as "Air-dried Vellums" are most notable in this respect. But their drying has probably been performed at a temperature too low to fuse the resin *(Pars. 105 and 114)*.

107. It will be remembered that in paragraph 59, it was said that after the paper had been moulded by the vatman, the coucher's work performed upon it, and it had been pressed and dried, the sheet required sizing. At this stage it is known as water-leaf, and resembles blotting. It may be compared to a sponge, which takes up water by capillary action.* The fibre alone can exert this action to some extent, but the principal factors in the soaking up of writing inks are the invisible crevices between the fibres. Unless these are efficiently filled by some suitable substance, they act as innumerable canals branching in every direction, into which a fluid is readily conducted.

108. Size, whatever its kind, connects one fibre with another, and makes a paper that presents to ink a comparatively solid, impermeable surface, in lieu of one of a spongy texture.

109. The methods by which papers are sized, are, tub-sizing (animal sizing) and engine-sizing (resin, starch, and soap sizing).

110. To tub-sizing must be given the first place. All hand-made writings and the best classes of machine-made writings are tub-sized. The size is prepared by boiling down scraps of hides, and cuttings of parchment (hence the term "animal-sized"), a jelly-like liquid being produced. It is gelatine. By various means it is clarified, so that its subsequent application will not detrimentally affect the colour of the paper. The addition of a little alum serves to prevent its putrefaction.

111. Hand-made papers, and those machine-mades which are really "air-dried," or "loft-dried," are sized by being dipped

* Capillary action is that exerted by fine tubes upon fluids. It may be exhibited by dipping one end of a fine glass tube into water, when a rise of the liquid occurs, which eventually *stands in the tube at a height above that of the surface in the dish.* In nature, this action serves important purposes. Plants take from their roots the moisture necessary for their well being, and the roots take it from the soil by this action. Hair is a particularly fine tube, and it extracts nourishing moisture from the head by capillarity.

twice or thrice into a vat (formerly a tub, hence the term "tub-sized"), and afterwards hung to dry naturally upon lines in a drying-room, or loft, where the temperature does not exceed 70 or 80 degrees Fahrenheit.

112. There is another method of tub-sizing by machine; the web being passed through a cistern containing the size, and from here over skeleton cylinders, travelling from floor to ceiling, and from ceiling to floor alternately, yet ever onward along an immense drying room where temperature is about 80 degrees Fahrenheit, until it is again reeled at the end of the room. All this is to ensure perfect drying at a low temperature, which is the great essential in animal-sizing. The two methods of imparting gelatine size are called "tub-sizing by hand," and "tub-sizing by machine," and it is frequently important to know this. Government specifications draw the distinction in asking for tenders for stationery.

113. Frequently, paper is engine-sized prior to tub-sizing.

114. Of engine-sizing not much is to be said. It derives its name from the fact of the size being added in the beating engine *(par. 36)*. On reference to that paragraph and the one following it, the reader learns how the resin is deposited around the fibre in infinitesimally small particles. But that is not the completion. Paper having merely a deposition of size round its fibre could not be recommended as a sized paper, since the result is simply an addition to the thickness of the fibre. Hitherto, nothing is done toward filling the interstices. In fact, they are not filled until the resin has been fused by the heat of the drying cylinders. Proof of this may be had if the reader can obtain a piece of paper from the machine before the drying cylinders are reached. At this point it will be moist. On drying slowly, and testing with pen and ink, it will be found that it behaves similarly to unsized paper. Afterwards pass the sheet between hot rollers (smoothing with a well-heated laundry iron answers equally as well), heating

sufficiently to cause the resin to fuse and run; and it will then bear writing upon.

Most printing papers, and all the commonest writings, are engine-sized.

115. Those printings which are not resin-sized are, with rare exceptions, unsized, and are the best kinds, used for first-class illustrated magazines, as *The Century*, *Art Journal*, *English Illustrated Magazine*, etc. These unsized papers owe their value for printing illustrations to their absorptive properties. The ink can be literally piled on the cuts, with the certainty that it will be soak in the paper directly. As the reverse of this, consider the effect of printing engravings on a heavily-sized writing paper: days scarcely serve to dry it, while the terrors of "setting off," and smearing are for ever present in the printer's mind, not only during the time that the work remains on his hands, but even after it has been sent out. A hard-sized writing presents a surface almost proof to printers' ink, which must here dry by oxidation, or not at all, for it cannot penetrate. It is suggested that paper makers might advantageously offer to printers papers of the qualities and sizes of writings—water-marks included—laid and wove—and tinted papers especially—without size. Where the printer was assured that the paper was not required for writing purposes, he would gratefully substitute it for the ordinary sized papers.

116. A good feel is imparted to paper by the addition of rice-starch and flour-paste to the engine-size. It plays a part in paper similar to that in finishing linen; imparting a rattling sound, and a solid, stiff feel. In addition, it is contended for starch that it permits the water to be retained longer on the wire cloth, thereby holding the fibres longer in suspension, and enabling them to interweave with each other to a much greater extent than if rapidly deprived of water. The sheet is rendered less absorbent, and it

requires less subsequent sizing with gelatine,– when gelatine is to be used. It also aids in fixing the clay in the pulp.

117. Since it is important to have an accurate knowledge of the qualities of paper, it is necessary for the completion of the information to be able to distinguish one kind of sizing from another.

118. The absence of size is detected by wetting with the tongue, and observing the aptitude of the paper for absorbing the moisture. Or, preferably, marking with writing ink, since its behaviour is more easily observed in this test, and the result is clearly visible.

119. The presence of animal size is determined by tearing from the sample some small pieces, placing in a test tube, and covering with water; boil the whole carefully for a minute or two, and then separate the clear liquid into another clean test tube by filtration. To this liquid add a single drop of tannic acid, when, if the sheet has been tub-sized, a white gelatinous-like substance is precipitated.

120. Frequently, the edges of a ream of paper indicate that it has been tub-sized; the thickness of the edges being greatly enhanced owing to the size being swollen by damp. When this occurs, the difficulty of cutting with guillotine is familiar.

121. A foul smell sometimes attends a tub-sized paper, denoting that the size has turned putrid.

122. Starch is found by dipping a corner of the paper into iodide of potassium, and then dropping upon this portion a drop or two of chlorine water. A very characteristic blue colouration —the blue iodide of starch—denotes the presence of starch.

123. On first determining, by paragraph 118, that size is present,—gelatine, starch, or resin, test first for gelatine, if no indication follows, it is evident that either starch or resin has been

used. Next test for starch, should this fail, the size must, by inference, be resin.

124. Suppose that it is necessary to prove the presence of resin. It should be remembered *(par. 113)* that the paper may be both tub- and engine-sized. Should this be the case, especial care will be needed to bring the tests to a satisfactory issue. First get rid of all the gelatine by boiling several times, each time pouring off the water and adding fresh. After having repeated this four or five times, test by paragraph 119 to see if any gelatine still remains in the water. *Being satisfied that no gelatine remains to confuse the test for resin*, the shreds of paper must be covered with spirit of wine, or methylated spirit, and permitted to stand for a few minutes. Then shake well, and pass the clear liquid through a clean filter-paper and funnel into a clean test tube. To this add a few drops of water until a slight white powdery precipitate appears, which is resin.

125. To determine which is the most efficiently sized of two samples of paper, it is necessary to prepare a test liquid by dissolving in methylated spirit a little aniline blue. On the two samples of paper drop, simultaneously if possible, a little of this preparation. Turn the papers over. The one through which the dye appears soonest contains the least size, and is therefore the least fitted for a writing paper in this respect.

126. To the finish on paper there is frequently too much importance attached. Some purchasers assume that a high finish is indicative of quality, and look for but little more.

127. Specimen No. 18 exhibits a surface that has never been subjected to pressure. Some drawing papers present this characteristic surface, being purposely left rough for the requirements of the artist.

128. Specimen No. 10 is a drawing paper, with what is termed the "mill finish." There are technically four varieties of surface imparted to drawing papers, B, BB, BBB, BBBB; B denoting

the smoothest, BBBB the roughest of the series. Some makers and dealers speak of the surfaces as R (rough), or very coarse surfaces, with a large and open grain *(specimen 18)*; N (not), a surface with a slight grain; HP (hot pressed), perfectly smooth surface; while some others refer to them as unrolled, mill finish, and highly rolled.

129. Writing papers receive a still greater variety of surface. All the above, except the very roughest, are commonly met with; and in addition, many are still more highly glazed.

130. Printing papers may also receive any finish.

Imparting finish to printings is usually a process coming within the department of the machine man. He can elect, at his pleasure, to reduce the suction in the exhaust boxes, and so leave more moisture in the pulp; reduce the pressure in the couching rolls for the furtherance of the same end; or lower the temperature of the drying cylinders. Thus, the web passes through the calender rolls in a comparatively moist state; which is a condition particularly favourable, being similar to that resorted to by a laundress when ironing linen. Damp linen and paper both receive a higher finish from the hot surfaces. Therefore a good finish can be secured at a cost which does not exceed that involved in the production of an inferior surface. *(Specimen 19)*. This method of leaving moisture for the purpose of finish is called "drying soft," in distinction to that of driving out all moisture, which is "drying hard."

The methods of imparting finish are various, and being known under many names, are apt to lead to some confusion.

131. Hot-pressing is an obsolete process. Sheets of paper were placed between glazed boards, and a pile of them raised. At intervals, smooth heated iron plates were inserted, and the whole stack inserted in a powerful press,—preferably hydraulic.

132. Plate Glazing, or super-calendering, appears to be the

substitute for the last process, and of all others, is the one that most nearly resembles it. A sheet of paper is placed between two finely-polished sheets of copper, or of zinc; or occasionally,

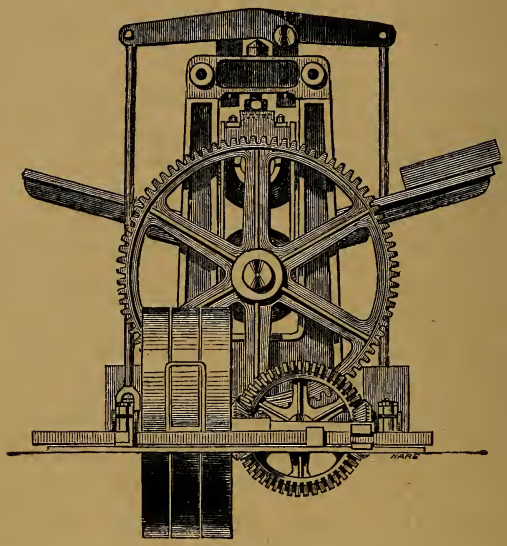


PLATE GLAZING MACHINE.

By the courtesy of Messrs. Bryan Donkin & Co., Bermondsey, London.

a sheet of each. A pile is raised, which is passed through a pair of powerful rollers, capable of imparting a pressure of from twenty to thirty tons. The oftener the sheets are submitted to this treatment, the higher is the finish they attain. The advantages are—the superiority of the surface imparted, without the corresponding thinning of the paper. It is an expensive system, being a comparatively slow one. Different sizes of plates are in use, a pair being required for each size of paper.

133. Calendering is the finish—known as "mill finish"—put on at the termination of the paper machine by the ordinary

calender rolls. These are heated for the ordinary finish. For a higher surface, two or more sets of rolls are employed, the paper passing through all.

134. For milling, which leaves a dead, or unglazed surface, the calender rolls are used, but without heat.

135. Rolling is another term for calendering, and usually implies nothing more than that the sheet has been passed through the rolls sufficiently to form a tolerably good surface.

136. Many printers and publishers use hot rolling machines, hydraulic presses, toggle presses, etc., erasing the pressure marks in typographical printing, and imparting a general appearance of neatness to printed work.

CHAPTER IV.

ON JUDGING PAPER, AND DISTINGUISHING MACHINE-MADE FROM HAND-MADE PAPERS.

137. It will have been noticed by most printers and stationers that many modern papers made by machinery bear a resemblance to hand-mades so close that at times it becomes a difficult matter to say with certainty of a given sample to which class it belongs. Even experts, as warehousemen and commercial travellers, are frequently undecided how to name a specimen; and the utmost information they impart on questioning is to the effect that hand-made papers can only be known by their feel, tear, and general appearance; the characteristics of these it is said to be impossible to explain, since they are only learnt by years of experience.

138. Any handling or general appearance claimed as specialities for hand-made may be questioned. But there is much in the tear that indicates whether the sheet under examination has been made by hand or machine. Machine-made papers are about 25 per cent. stronger one way than the other, while hand-mades are almost equally strong in each direction. The causes are discussed in a previous chapter, "Hand-made *versus* Machine-made Papers."

In consequence of these characteristics it is found that a machine paper tears with a rougher edge, and with more difficulty, in one direction than in the other; while a vat paper discloses equally fibrous edges in any direction.

It is now endeavoured to impart knowledge that will suffice at all times to distinguish one kind from the other.

139. In addition to the peculiarities given in the foregoing paragraph, there are the means of distinguishing hand-made by—

(a) *Its rough edges*, which will be familiar to most printers and stationers. These rough edges are never cut away in the mill, and the sheets are invariably received with either all four edges rough, or with three, as in Bank of England notes; the fourth being smooth because two notes have been moulded together, and afterwards cut in two. *(Specimen 4).* When the rough edges are trimmed away on making the paper into books, this method of identification is lost. It should be mentioned that an arrangement is now working by which rough edges are secured for paper made by machine.

(b) When writings are yellow wove, azure laid, or blue, they are frequently darker on one side than on the other. *(par. 61). When the paper is darker in colour on the right side, it is hand-made; when darker on the wrong side, it is machine-made. (par. 156).* This method of distinguishing cannot be taken as conclusive without corroboration from other sources, for means are now taken on the machines in some mills to counteract the subsidence of the blue pigment. It may happen that this rule fails, owing to a high finish having been imparted to the right side of a machine paper, by which it would become darker on that side. *(Par. 149).*

(c) On having his attention again drawn to paragraphs 70, 71, and 82, on laid and wove paper, the uses of the dandy roll, and suction boxes, the reader will be prepared to learn that an unsought watermark is impressed by the wire cloth on all papers made by machine. This mark is especially noticeable in the

numbered side of specimen 15. It is indelible. No after-process of surfacing can obliterate it. *It is always present in laid machine papers, but is never found in laid hand-mades.* The mark, which is a fac-simile of the wire cloth, owes its existence principally to the suction of the exhaust boxes; and according to the intensity of their action on the fibre, so does the texture-like impression in the finished sheet vary. Hence it is more distinct in some papers than others. With a very fine wire, light action in the exhaust boxes, and a good finish afterwards, these wire-marks get so faint that they are only discernible on looking through the sheet at a strong light. Two marks, laid and wove, in the same sheet, are an infallible indication of the sample being made by machine.

(d) With wove papers the detection gets more difficult. The same texture is imparted to all wove papers, irrespective of make. As a rule, to which, however, the exceptions are frequent, the wire marks are not so deep in vat as in machine papers, owing to the non-intervention of exhaust boxes. The marks can usually be seen by looking *along* the surface of machine-mades, which is not the case with those made in a mould. Should the watermark be available, a method of identification similar to that in section *c* becomes practicable. In a machine paper the watermark will be regularly impressed by the wire cloth marks. In a hand-made this combination is impossible, because the emblems and letters of wire cover the woven wire, and so prevent it marking. Further, it is well worthy of notice that the wire upon which a wove hand-made is moulded is of a much coarser mesh. The coarsest contains 40 meshes per inch, and the finest 60. The wires on a machine reach 80 meshes per inch. *(Specimens 20 and 25).*

140. An experienced man, on handling a sheet of paper offered for inspection, will probably take all its points under review simultaneously: judge it as a whole. Of a person not well acquainted with the qualities of paper, this, of course, could not

be expected; and he will be contented to take the points of excellence, or defects, in detail.

Many of the characteristics by which good and indifferent papers are distinguished will, it is hoped, have been deduced from the foregoing pages; but some further remarks remain to be added; and then it is to be presumed that such matters as price, and the setting off of a quality against a fault, must be left to the judgment of the purchaser, which, it is almost needless to add, can only become perfected by experience.

141. Abundance of pulp of good quality is undoubtedly the most satisfactory method of imparting a good substantial feel to paper. But it is also the most expensive. Then in order to meet the simultaneous calls for material of a good appearance and low prices, it was necessary to substitute something comparatively inexpensive; and this was found in alum to a slight extent, and starch. The uses of alum have been alluded to in paragraph 39; those of starch in paragraph 116. When starching is suspected to a great extent, the only other test is in the strength *(par. 90)*.

142. Most kinds of material are weaker as they increase in size. A long iron bar is more easily broken than a short one. A double demy forme has an aggravating leaning towards falling through, that is only shared to a slight extent by a small-card forme. A whole piece of paper does not handle so well as, say, an octavo or sixteenmo cut from it. Therefore the saying, that a sheet handles better on being cut up.

143. By "good colour," is understood the brightness of the sample, as contrasted with the dull opaque appearance presented by one that has had colour added to the pulp in order to disguise its inefficient boiling and bleaching.

144. A paragraph may be reasonably devoted to the meaning of "colour." When a quantity of half-stuff has been bleached, and is transferred to the beating engine for complete conversion into pulp, it presents that greyness characteristic to cartridge

papers. (*Specimen* 21). Reverting to paragraph 37, it will be remembered that, singularly, a little colouring, red and blue, is added at this stage for the purpose of giving whiteness. The absurdity in a laundress expecting to turn a dirty collar to white by substituting bluing for washing is only equalled by a paper-maker looking for a bright white pulp from a badly-boiled and bleached engine of half-stuff by tempering it with colour. Indeed, it is obvious that if more colouring is added after a certain point to even a well-bleached paper, it would overshoot the object, and if carried on, would eventually turn the stuff a dark purple. Thus it should be seen that colouring has a definite object, and that it cannot lend whiteness after inferior manipulation of the pulp; and that an excess gives opacity instead of brightness and transparency.

145. The reader can also attach a precise value to the meaning of a white paper possessing a shade of blue which is not shared by another. Excess of blue has been added to the pulp. A second sample has a warm appearance from the excess of red colouring matter. This is frequently done as a matter of taste.

146. A somewhat lengthened exposition of this section has been given; necessarily given, it is thought; for on reference to a work that has now been before stationers and printers for some years, the reader is told that a blue writing increases in value as the colour increases in depth. This is not so, for it will be readily perceived that nothing would be easier or cheaper than to add an extra quantity of blue to an inferior pulp, and sell the product as a first-class blue-laid or wove.

147. By a severe course of bleaching (which it must be remembered carries with it the great evil of weakening the fibre, and so producing a tender paper) even an inferior material may be, and is, rendered fit for a white paper of good appearance. But a coarse material, such as is here imagined, and whose nature is opposed to bleaching, is always tending to resume its normal

state; and this may be frequently observed in paper which is partly exposed: that part re-acquires the brownish tinge of the raw material.

148. In another part of this work it has been attempted to set the finishing in a clear light; and it is hoped that this will enable its value to be understood. Nothing much remains but to say that the highest finish can be given to a very inferior material, even a common handbill paper; specimens are annexed *(Nos. 6 and 7)*, showing the same paper in a rough and in a highly finished state. Also of a biscuit paper *(Specimen 19)*.

149. Cleanliness in manufacture is exhibited by an absence of those black specks, and dark stains generally, which mar so many otherwise handsome papers. The specks are due to the presence of such matters as refuse to be acted upon by the ordinary bleaching agent. The persons mainly responsible for their presence are the pickers and sorters, who ought to have turned them out at the cutting tables. India-rubber, which is used for various purposes in wearing apparel, is said to be largely the cause of those black specks. Fragments of iron get into the pulp at various stages, these oxidized, as they readily are, leave yellow stains in paper. Finishing invariably exaggerates these blemishes; and specks and stains, till then unnoticed, now stand out distinctly. *(Par. 139 b)*.

150. For much of the uniformity in thickness of paper, the machineman is responsible. By careful attention to the means of freeing from knots, and the shake on the wire, he prevents the pulp from clotting and forming in the patchy way of which numerous examples may be seen in cheap papers. It is said, and with some semblance of truth, that a machineman can raise the value of paper a halfpenny per pound by a careful manipulation on the machine.

151. But although uniformity is desirable, it must be demonstrated that at times it is attained at the cost of the strength. Frequently, in making a common printing, the speed of the paper

machine is such that the shake has not the opportunity of acting with its maximum distributing power; and the pulp is clotted, and the paper cloudy, in the face of all that the machineman can do to prevent it. So he steps into the room where the beaterman reigns, and induces him to cut the fibre shorter.

152. Grease spots are those portions of the paper where there is a paucity of pulp. At times not much larger than pinheads, they present a ragged appearance when examined by holding to to the light. They are caused by the pulp refusing to lodge upon such parts of the wire cloth that are a little greasy. They may also be caused by the wire being buckled or bent at any point. These marks are not to be confused with those of esparto, which also appear as minute transparencies.

153. Strength, and the means of testing it, have been sufficiently well elucidated in paragraph 90. The reader may be reminded that in judging paper he will probably be guided by the general characteristics at times, and select that which partakes of all the good qualities in a moderate degree—feel, colour, finish, cleanness, regularity of the pulp, and strength; at other times, strength will be the desideratum, and he will find that a cartridge paper meets its requirements; thus he sacrifices colour and finish. He will be prepared to learn, however, that a paper which is excellent in all points will command a good price.

154. Taking note of the fluctuations in prices, it has been deemed inadvisable to make even an attempt to indicate the value of papers, etc. As is to be expected, they vary with different mills; and in the warehouses they have a still wider variation.

155. When a mill commences on an order which causes a change in perhaps the material, colour, weight, and finish, it is to be expected that the first portions that are made will be faulty in either one or more of the particulars. These first parts are separated from the remainder—the good sheets, and are known as imperfections, or retree. In the warehouse, they are marked

with a large R on the wrapper or two crosses × ×, or the × × may be on the front edges of the ream. If the paper is folded, the quires are placed with their fronts and backs in pairs; while in good paper the quires are placed alternately back and front. If the paper is broken (though this is seldom sold) it is marked B× ×. Some mills do not attempt to sell their imperfections, but return them to the beaterman, to be re-converted to pulp. Frequently, the retree is invoiced at a lower rate to the customer for whom the order is made.

When cards in packs are sold as retree, the fact is indicated by the wrappers being folded inside out—the printing inside.

CHAPTER V.

THE RIGHT AND WRONG SIDES OF PAPER.

156. *(a)* Roughness of surface cannot be said to invariably indicate the wrong side of paper. Some misconception prevails on this point; but proof is readily obtained from papers for crayon and chalk drawings. *(See also specimen 18).* The roughest side there is the right side. Specimen 15 has had nearly all the finish given to the marked side, in order to retain the slight roughness of the other surface.

(b) On opening a ream of flat paper (*i.e.*, unfolded), the right side is the top side.

(c) When paper is folded into quires, it is right side out.

(d) The lettering of the watermarks can only be read from the right side of the paper.

(e) When papers are azure laid, yellow wove, or blue, they are, if machine-made, usually darker on the wrong side; if hand-mades, the right side is the darker. *(Par. 139).*

(f) Some of these characteristics may be absent, and then an independent test becomes necessary. This is found in the wire cloth mark, which has been referred to more than once. When everything else fails, this points out the wrong side. There are

but few exceptions to this rule, since it is seldom the exhaust boxes act so lightly that the finishing obliterates the marks they leave.*

The wrong side of a granite paper is denoted by all the fibre being set in the same direction. *(Specimen 2 and paragraph 98).*

It is worth mentioning that the wire side is only the wrong side when speaking of machine-made papers. In hand-made paper it is the right side. This is rather odd, for undoubtedly the top side would give the most suitable surface.

* It has been said, in paragraph 139, that these marks can always be seen, however faint, by holding up to a strong light. That is so, but it would not determine *upon which side the marks were made.*

CHAPTER VI.

NAMES, SIZES, AND WEIGHTS OF PAPER AND CARDS.

157. Most writers on paper have treated of the names of papers, and how they have probably been derived. Although the subject is without practical value, it is thought that a want of completeness might be urged if it were omitted here. The compiler to bound to add, however, that the matter is one in which he is quite unable to attempt further research; and that, in consequence, he is indebted entirely to those who have preceded him for the paragraphs which bear on this subject.

158. Pott is so named from its original distinguishing mark of a tankard or pot. Frequently now by the royal arms within a shield, without mottoes or supporters.

159. Foolscap, from the fool's cap and bells. Now, the water-mark is usually either a Britannia or a lion rampant surmounted by a crown.

160. Hand is a size of no interest to the printers. It takes its name from the watermark of an open hand with a star over the fore-finger. There are middle hands, lumber hands, royal hands, and double small hands.

161. Post was a size which came into use with the postal system. It was the custom for the guard of the coach carrying

the mails to sound a horn on nearing a village. Even now, in country districts, where houses are very much scattered, and frequently situated at some distance from the road side, the postman blows a horn on approaching a house for which he has a letter; acting on this notification someone meets him, takes the letter, and saves the postman's time. On this size of paper was a more or less ornamental postman's horn, either with or without a shield and crown.

162. Demy, and several larger sizes, are even yet marked with a fleur-de-lys in a shield with a crown.

163. Copy, by fleur-de-lys alone.

164. Royal, by shield with bend sinister, and fleur-de-lys and crest.

165. Imperial was given by the ancients to their finest papers, and has been handed down to us.

166. That the various emblems used as watermarks bear no evidence in determining the sizes of paper, is evident from the circumstance that the same mark is found adorning several sizes. At one time this was not so, and if the symbol could be seen, the size was readily named.

167. The waterlines in a laid paper may determine from what size a given sheet is cut. Observe that in laid the tying wires are more strongly marked than the others, and are much further apart. *These wires always lie across the narrow way of the sheet.* Then in folio, the wires must run the long way; in quarto, they are the narrow way; in octavo, the long way, and so on.

168. An examination of the Table of Papers and Boards reveals that the various qualities bearing the same name, frequently differ very materially in size; and that some of the sizes are peculiar to one class only. As an example, take post—large or small. These are always purchased as writings; never as ledger papers, drawings, printings, or boards, except to order, when of course, any size may be had, and in any quality.

169. It will be of no little assistance to a person desirous of committing these tables to memory, if the similarity in the sizes of some papers be noted; and that others bearing different names are *practically* identical in size; the distinction being in the quality.

Pott is equivalent to crown in one direction.

Foolscap is practically either demy printing or large post in one direction.

Small post is royal drawing in one direction, and nearly crown in the other.

Crown is synonymous with demy book and drawing paper.

Demy. See foolscap and crown.

Copy, equal to crown one way, and large post the other.

Large post is super royal printing in one way, and foolscap the other.

Sheet-and-third foolscap is changed from the *short* way to the *long* way of demy.

Medium drawing, book, and writing, are practically the size of demy printing; while a printing medium is equivalent to small post in one way, and elephant the other.

Royal, as a printing, is crown in one direction, and is sheet-and-half foolscap in the other.

Sheet-and-half foolscap. See royal.

Double foolscap. Narrow way of demy in one direction, and demy-and-quarter (long way) in the other.

Super royal is equivalent to double foolscap one way, and to small post the other.

Elephant. See medium.

Imperial is double crown by double demy.

Double pott equals royal printing by crown.

Double post closely resembles double crown.

170. In the manufacture of paper, the machineman must be able to say at a few minutes' notice what weight is being made, from trial. He tears from the reel a large piece of paper, and

TABLE 3. SIZES OF PAPER, BOARDS, AND CARDS.

Names.	Drawing Papers.	A.C Book Papers.	Writing Papers.	Printings.	Cartridge Papers.	Bristol Bds.	Bristol Bds. Cut Edges.	Card and Paste Bds.	Show Bds. Cut Edges.	Ticket Bds. Uncut.
Pott	...	...	15 × 12½	15 × 12½	...	...	...	...	...	...
Quarter Foolscap	...	...	...	...	...	...	...	...	8 × 6⅜	...
Half Foolscap	...	...	...	...	...	...	...	...	12¾ × 8	...
Foolscap	...	17 × 13¼	17 × 13¼	17 × 13¼	18¾ × 14	15 × 12¾	15 × 12¾	17 × 13½	16 × 12¾	...
Small Post (or Post)	...	...	18¾ × 15¼	...	...	...	...	...	...	...
Crown	...	...	...	20 × 15	...	...	...	...	...	...
Demy	20 × 15½	20 × 15½	...	22½ × 17¾	22½ × 17¾	18 × 14½	18½ × 14½	22½ × 17½	...	...
Copy	...	...	20 × 16½	...	...	...	...	...	...	...
Large Post (or Extra Post)	...	...	20¾ × 16½	...	...	...	...	...	...	...
Sheet-and-Third Foolscap	...	22 × 13¼	22 × 13¼	...	...	...	...	...	...	...
Medium	22 × 17½	22 × 17½	22 × 17½	23 × 18¼	...	21 × 16½	21 × 16½	...	...	...
Half Royal	...	...	...	...	...	...	...	...	19 × 12	...
Royal	24 × 19	24 × 19	...	25 × 20	24 × 19	22¼ × 18	22¼ × 18	25 × 20	24 × 19	25 × 20
Sheet-and-Half Foolscap	...	24⅛ × 13¼	24½ × 13¼	...	...	...	...	...	...	...
Double Foolscap	...	27 × 17	27 × 17	27 × 17	27 × 17	...	...	27 × 17	25½ × 16	...
Half Super Royal	...	...	...	...	...	...	...	...	19 × 12¾	...
Super Royal	27½ × 19	27½ × 19	...	27 × 21	27½ × 19¼	...	...	28 × 22	25½ × 19	27 × 20
Elephant	28 × 23	...	...	...	28 × 23	...	...	...	...	...
Half Imperial	...	...	...	...	..	...	...	...	21 × 14¼	...
Imperial	30 × 22	30 × 22	...	30 × 22	30 × 22	28 × 20½	28 × 20½	30 × 22½	28½ × 21	30 × 22
Double Pott	...	...	25 × 15	25 × 15	...	...	...	...	...	...
Double Crown	...	...	...	30 × 20	30 × 20	...	...	30 × 20	...	...
Double Post	...	...	30½ × 19	...	...	...	...	...	...	...
Atlas	34 × 26	...	...	...	...	...	...	...	...	...
Colombier (or Columbia)	34½ × 23½	...	...	...	...	...	...	...	...	...
Double Demy	...	...	...	35½ × 22½	...	...	...	...	...	...
Double Royal	38 × 24	...	...	40 × 25	...	...	...	...	...	...
Double Elephant	40 × 27	...	...	...	...	...	...	...	...	...
Grand Eagle	43½ × 28½	...	...	...	...	...	...	...	...	...
Double Imperial	44 × 30	...	...	...	...	...	...	...	...	...
Antiquarian	53 × 31	...	...	...	...	...	...	...	...	...

Sizes vary with different makers. There are also many odd sizes made for publishers. This Table only professes to show those which are most generally in use.

cuts out of it a sheet of the size which is on order. Folding it, he places it in a pair of delicate scales, and tests it for the weight it ought to be. The weights are interesting. They are not the ordinary drams and ounces; each represents the weight of a sheet of paper; that is, each weight is the 480th part of a ream of paper. Of course, the reams vary in weight and size, and the weights are of sufficient variety to meet all requirements. The size of sheet is of no consequence, since a 24lb. demy, double crown, or any size would take the same weight to balance it. On each weight its equivalent is marked. The machineman, whose order might be for an 18lb. double crown, would balance a sheet of that size against a weight marked 18lb.

171. If the sample should prove a pound or so short in weight, there are two remedies: the stuff valve may be opened out more, and the deficiency made up with pulp; or part of the moisture may be permitted to remain, which would also add to the weight. Evidently, the retention of water is the most economical course. It is but right to point out that if "dried hard," the paper absorbs moisture after leaving the mill, thereby becoming above weight.

172. The weight of any size of paper can be calculated from the weight of another size by Simple Proportion.

Example:—If a ream of double crown equals 30lbs., what will royal, of a similar quality, weigh?

20in. × 30in. : 20in. × 25in. : : 30lbs. : x

Therefore, 600 sq. in. : 500 sq. in. : : 30lbs. : 25lbs.

The royal would weigh 25lbs.

In this way the weight of a paper can be deduced from that of a single sheet, or even part of a sheet. By measuring the piece, and multiplying the length by the breadth, the number of square inches are determined, which form the basis of the calculation.

Example:—A piece of paper, which has been cut from any size, weighs 12·8 drams, and measures 12in. × 8in. What will be the weight of a ream of demy drawing paper of similar quality?

In this instance, act upon the hypothesis that the size is a standard one, and ascertain what would be the weight of a ream of it:—

12·8drs. × 480 = 24lbs.

Then, as in the former example, compare the ascertained weight and size with that size of which the weight is required. Demy drawing is 15in. × 20in.

12in. × 8in. : 20in. × 15in. : : 24lbs. : x

Therefore, 96 sq. in : 300 sq in. : : 24lbs. : 75lbs

The demy would weigh 75lbs.

173. Formerly, reams of writing only contained 472 sheets; out of these, two sections of twenty each were of damaged paper, practically, retree. One of these sections was placed above, and the other below, the remaining eighteen quires of paper; and from this circumstance were termed "outsides." The custom only remains with the hand-mades now; and even here it is becoming customary to assort the paper, making up perfect into reams, and the remainder going out as retree. The name given to the ream of perfect and outsides is "mill ream." A ream of good paper is called a ream of insides.

Printing paper is usually purchased with 480 sheets to the ream by general printers; but they are often sent out with 500 sheets; while a "perfect" ream, as it is called, contains 516 sheets, or 21½ quires. But a mill will make up any number of sheets in a ream—500, 504, 506, 512—according to the customer's instructions.

The reams of printings are all good, or "insides," unless sold as retree.

CHAPTER VII.

MISCELLANEOUS QUALITIES OF PAPER AND CARDS.

174. *Bank Posts.* A fine, hard-sized, heavily-rolled writing. *(Specimen 22).* On account of its light weight, it is largely used for foreign correspondence. Frequently water-lined similarly to linear note paper. May be had in several sizes, the most usual being large post and medium.

175. *Blotting Paper (specimen 12)* is familiar to everyone. Unsized. Made in demy and double foolscap. Rarely met with in royal, except as the thin kind used for interleaving. Many colours can be had, but the most usual are red and white.

176. *Book Lining Papers* are surface-coloured papers of good qualities. Their use is that of making ends for printed books; hence they are also known as end papers.

177. *Brief Paper* is a foolscap broadside, having a marginal line down the left-hand of the sheet, from this are feint lines, in number, either 36 or 42.

178. *Bristol Boards* are a very fine description of cardboard. They are made of good white middles as described in the manufacture of cardboard, but having drawing paper for the outside sheets.

179. *Cardboards* are of a kind partly resembling paste-board. From these, however, they differ by having an inside of white paper; for the finer qualities these insides are of cartridge. The

cards receive any degree of finish by rolling. Their thicknesses are determined technically by their names; being known as three-sheet, four-sheet, etc.

180. *Cartridge Papers (specimen 21)* are of a particularly strong character. They do not differ materially from drawing papers (for the commoner of which they are substituted) except in the circumstance that the pulp is left uncoloured; consequently these papers are always of a grey tone, the particular phrase for them being that they are "self-coloured." They were originally manufactured for making cartridges, and from this circumstance take their name.

181. *Commercial Cards*, so named in distinction to ivory cards, are various in qualities, accordingly as they are cut from paste or cardboard. The sizes will be found in the table.

182. *Copy Paper* is used only by solicitors. and is known by them as rough draft paper. In size it is 20 × 16½, being between large and small post.

183. *Copying Paper (specimen 14)* which is usually made in foolscap and medium, bears a close resemblance to tissue paper, being very thin, strong, and unsized. It receives a higher finish than tissue. The ordinary kind is white; but there is another kind of copying, deep buff in colour, and much thicker in substance. Copying paper is made into books,—copying books; and the ink used with them is copying ink. When a letter requires to be copied, a leaf of the copying book is wetted by a broad soft brush. The letter is laid face down upon it, the book closed, and submitted to pressure in a copying press. The water serves to revive the ink, which, being of a sugary nature, has dried on the surface; and the copying paper, being bibulous, absorbs some of the moistened ink, after the way of blotting. The copy resembles type, being reversed, but the paper being thin, the letter may be read from the other side.

184. *Drying Paper* resembles blotting in its power of absorption, but is very much stronger. It is used for taking up the superfluous water in copying books. Made in royal. White.

185. *Duplex Papers* resemble surface coloured papers in the circumstance that they are coloured on one side only. They are made by a coloured sheet being mounted on a white one, and are superior in quality to surface papers. Used for pamphlet covers.

186. *Enamelled Paper and Cards* are prepared by coating with a mixture of zinc white with some mucilaginous material for purposes of adhesion. Another substance used for enamelling is white lead mixed with size from parchment clippings. The surface is burnished by revolving brushes, or other means. Some difficulty is often experienced by the enamel peeling off when printed on, and this is frequently due to want of age; or to the cards being slightly damp.

Enamelled papers, with a dead surface, are used largely in chromo printing; a finer impression being attainable; the coloured ink being readily absorbed; and the paper not being liable to stretch, as is usual with damped papers.

187. *Filtering Paper* may be described as a kind of blotting, but stronger, and usually thinner. The main characteristic of a filtering paper is its purity. Used almost solely by the chemical and medical professions for the separation of one substance from another, and taking, as it does, important parts in extremely delicate chemical processes, it is of the utmost consequence that it should be without chemical action on any substance passing through. Hence it is prepared without acidity or alkalinity, and free from mineral matter such as china clay, or other loading matter.

188. *India Proof Paper* is made from the inner part of bamboo stalks. It is of a dirty straw colour, and is used for what are

termed proof engravings, and by wood engravers to get the best possible effects for their proofs. Of a peculiarly soft, silky nature, and without size, it follows that it adapts itself to the surface of the steel plate or wood, and soaks up an enormous quantity of ink without afterwards smearing.

189. *Ivory Cards* differ from commercial cards in that they are of better material, and they are built up generally without the aid of paste, in manner described for plate papers. There is, however, no rule for their make; for the sheets may be pasted; or the card may be made of one thickness only. The point to be observed in their manufacture is to attain a transparency unknown in commercial cards.

190. *Lithographic Paper*, by which is meant paper for lithographic printing, is most suitable when in an under-sized state, for reasons previously given, viz., that it absorbs printing ink readily. A lithographer does not use a heavily-sized paper from choice, such as hand-made loan papers; neither, if he can avoid it, will he print upon a rough paper; he prefers rolled; for this reason, it but comparatively seldom occurs that lithography is executed upon laid paper; wove being that almost invariably selected.

191. *Loan Papers (specimen 20)* are particularly strong hard-sized papers, made principally in the sizes of book papers. Used for scrip, policies, bills of exchange, and any documents that are required to withstand much usage. They are invariably wove. May be had either cream or blue.

192. *London Boards*, closely resembling Bristol boards, but being of Balston's drawing paper throughout.

193. *Manifold Paper (specimen 26)* is used for copying purposes, or for multiplying the number of copies from one writing. It is prepared by smearing evenly one or both sides of a fine printing paper with a mixture of lard and lamp black. Being dry, the surface is smoothed by a piece of cotton. The paper to be written upon is placed on this black paper; that for the transfer

to be taken on is underneath. By writing on the top sheet with a lead pencil or other hard point, a second copy is obtained by the impression through the manifold paper. Manifold paper is used for copying telegrams in the post office.

194. *Metallic Paper (specimen 23)* is used solely for pocket books, and can be readily written upon with a metallic style, or a pencil made of the *metal* lead. It is a very heavy paper, resembling enamelled paper in this respect. Zinc white is the substance used for giving the character, and it may be added to the pulp to the extent of 30 to 50 per cent., or, as is more usual, brushed over the surface of the paper. China clay, whiting, lime, and barytes, may be used in lieu of zinc white.

195. *Middles* are the materials, white or grey, that go to form the interior layers of card and pasteboards. They are to be had in the various card and pasteboard sizes, and of different qualities and thicknesses.

196. *Oiled Royal.* A strong book paper saturated with linseed oil, which renders it water-proof, and suitable for use in a copying book; being placed under the leaf while damping.

197. *Pasteboards* are composed of a sheet of thin grey middles covered on each side with white paper. When one side is coloured the variety is known as a magpie or button board. Pasteboards are the commonest of all boards made by pasting.

198. *Photographic Paper* is a good printing paper, having a very high degree of purity, especially from iron and chemicals. For this reason, the pulp used in its manufacture is prepared in beating engines which are constucted of stone, and lined with glazed tiles.

199. *Plate Papers (specimen 16)* are generally examples of a good quality. The best of these—those used for printing from steel-plate engravings, hence the name—are made of two or three thicknesses of fine unsized paper. They are caused to adhere by moisture and pressure alone while in the web or process of

manufacture, and without any mucilaginous substance. The sizes correspond with those of drawing papers.

200. *Straw Boards.* A cheap material used by bookbinders as a substitute for millboards. They are, as their name implies, made from straw; while there is some authority for stating that they are on a large scale prepared from stable-yard matter. The range of sizes and weights is more limited than that of millboards.

201. *Tissue Paper (specimen 13)* may be purchased in almost any shade of colour. It is a paper having great strength compared with its weight. Unsized. Usually made as double crown, though quad crown and demy may be had.

202. *Tracing Paper* is a thin fine paper, preferably tissue, rendered transparent by a mixture of equal parts of Canada balsam and turpentine. For Canada balsam may be substituted nut oil, but the paper attains a yellow tinge in consequence, although a higher state of flexibility is given. The most economical way of preparing tracing paper is to commence with about a quire of paper, and saturate the top sheet, using either a brush or a sponge. The surplus runs through to the next sheet, and by the time the bottom sheets are reached, they have absorbed nearly enough from the top ones. Tracing paper intended for use with water colours must be washed with ox gall and dried again.

203. *Vegetable Parchment (specimen 24)* is now becoming common, being used largely by provision dealers for wrapping round butter, lard, etc.; and by fruit preservers for covering their jars. It is a class of paper in which much interest has been taken by experimental chemists, on account of the changes which are undergone in the transformation from paper of ordinary fibre to an apparently homogeneous mass. A description of the changes and properties of the product are given here.

Cellulose is the matter forming the walls or cells of plants. Cotton, and the linen fibre from flax, when washed to get rid of resinous and other matters, by being boiled with alkalies, alcohol,

or ether, are examples of a nearly pure cellulose. Hence, an unsized paper is cellulose, answering this description by being formed from purified cotton and linen rags. It has the same chemical formula as starch, from which, however, it differs in well-marked respects. It is insoluble in water, alcohol, or ether, while starch is soluble on long boiling in water. Starch forms with free iodine the blue iodide of starch *(par. 122)*, while cellulose forms, under similar circumstances, a yellow iodide. With nitric acid and with sulphuric acid it forms two distinct and important compounds, viz., gun-cotton* (nitro-cellulose, or tri-nitro cellulose) with nitric acid; and amyloid with sulphuric acid.

Strong sulphuric acid poured upon a piece of unsized paper (tissue or copying paper is suitable), dissolves it, yielding a solution of a brownish colour. Let the solution stand undisturbed for some time, and then cautiously add water; the liquid becomes colourless. If the solution be now boiled there will be produced a white precipitate having a flocky appearance. This is amyloid. Separate it from the liquid and test with iodide of potassium *(par. 122)*; it now gives the *blue* iodide, similarly to starch.

Preparation of Vegetable Parchment. Cautiously add concentrated sulphuric acid to half its bulk of water, and permit the mixture (which becomes very hot) to cool to the temperature of the room. Dip into it, for half-a-minute or so, dry unsized paper; then quickly remove the excess of acid by dipping the paper in water; and neutralise any that may still remain by dipping into an alkali—soda, potash, or ammonia—and dry slowly.

The reason of the change will now be understood. Strong sulphuric acid, after continuous action, dissolves the vegetable fibre. A diluted acid, acting but a short time, only partly dissolves

* With gun cotton this work is not concerned; but it is of singular importance to the printer, since it is the basis of celluloid, which has been proposed as a suitable material for stereotyping. This will be heard of in a future volume.

it; and the resulting semi-dissolved glutinous amyloid coagulates on the surfaces; protects the under portions of fibre; and presents a waterproof surface.

Vegetable parchment appears at its best strength when wet.

INDEX.

Absence of size, tests for the 118
Absorptive value of unsized paper 115
Abuses of loading material 84
Account book papers 76
Acidity of paper 88
Acid, tannic 119
Adulteration of paper 35
Determination of extent 85
Advantages of plate-glazing 132
Air-drying, 111
Alkalies 24
Alkalinity of paper 88
its effect upon inks 88
Alum 141
its uses 39, 110
Analogy between paper and linen 37, 116, 130
Aniline colours 37
blue 125
Animal sizing 83
preparation of 110
tests for 119, 120, 121
Antichlor 32
Antiquarian hand-made 57
Appearance 89
of fibre 49, 98
Apron 66
Archil 37
Arnot, Mr. 7, 9, 12, 14, 88
Ascertaining weight of paper 170
Ash in cotton-plant 84
paper 84
determination of per centage 85
straw 84
Assimilation of soil 84
Azure laid, meaning of 76

Bank notes 96
from linen rags 6
rough edges of 139 *a*
post 174
Barytes 35
Batchelor and Son 81
Beating engine 32, 44, 114
Black specks in paper 149
Bleaching 92
description of 30
engine 44
inferior material 147
jute, difficulty of 12
plant-fibre 1
woollen and silk rags, difficulty of 1
Blotting paper 106 175
Blue in linen and paper 37
high specific gravity of 61
iodide of starch 122
ultramarine 37
Blueness no indication of quality 146
Boiling 24, 92
aim of 24
Boilers, stationary and revolving 25
Book lining paper 176
Breaking points of papers 101
Brief paper 177
Bristol boards 178
Busbridge, Mr. 97, 103
Butter paper, clay in 84

Calendering 133
Capillary action 107
Calcic chloride 33
sulphate 35
Calculating weight of paper 172
Cardboard 179
Cartridge papers, greyness of 144, 153, 180
Caustic alkalies 24
Characteristics of paper with ad witho ut size 106
Chemical division and precipitation 39
China clay 35
abuses of 84
uses of 35
Chlorine 32
water 122
Choice of fibre, how limited 2
Classes of paper 76
Clay, curious effect of in toned paper 87
and size 86
example of determination of 85
fastening in the pulp 39
fixed by starch 116
in butter paper and label cloth 84
Cleanliness in manufacture 149
Cloth of wire 67
Cloudy paper 151
Coarse bags 10
material, bleaching of 147
wire as a test for wove vat paper 139 *d*
Cochineal 37
Coloured papers 38
Colour 143, 144
as a test for hand-mades 139 *b*
Colouring the pulp 37 61
excesses in 145
Commercial cards 181
Comminution of rags, former 43
Comparison of strengths of paper 90
contrivance for 90
hand- and machine-mades 93, 101, 102
Connection of sizing and finish 106
fibres with size 108
Considerations in choice of fibre 2
Contraction denied to machine papers 100
of hand-made papers 96
royal, hypothetical 100
paper no mark of strength 100
Copper plates in plate glazing 132
Copy 163 169, 182
Copying paper 183
Cotton fibre, microscopical features of 9
rags for printing papers 8
Couching hand-made papers 51
rolls 72
Cow-hair ropes 58
Crops, rotation of 84
Crown 169
Cutting rags 18
by the willow 20
Cylinders for drying 74

Dandy roll 71, 139 *c*
description and uses of 82
Dark and light sides of paper 61
Darkening paper by finishing 139 *b*
Dead surface, imparting a 134
Deckle 49
straps, 69
Definitions of good paper 83

Demy 162, 169
Denial of contraction to machine papers 100
Description of hand-mould 48, 82
Determination of clay, example of 85
efficient sizing 125
weight of paper 179
Difference between hand- and machine-made papers 44
Difficulties in sizing writings 105
Difficulty in detecting wove machine papers 139 *d*
of distinguishing hand-made papers 137
Dilution of the pulp 63
Direction label cloth, clay in 84
Distance the pulp travels 68
Distinguishing hand- from machine-made papers 137
the different kinds of size 117
Distribution of pulp in machine-papers 98
Division of paper into classes 76
Doctor blade 65
Double foolscap 169
post 169
pott 169
Draining off the bleach 30
Drawing papers 77
Drawing papers, and their finish 128
Drum washer 28, 32
Drying cylinders 74, 92, 112
hand-made papers 58
hard and soft 130
the paper 74
paper 184
room 112
Duplex papers 185
Duster 44
Dusting machine 19
Dutch hand-made 106

Effect of printers' ink upon hard-sized papers 115
Efficient sizing, determination of 125
Elephant 169
Enamelled paper 186
Engines, beating 32, 114
washing and breaking 26, 27
Engine sizing, explanation of 114
Erasures in tub- and engine-sized papers 105
Esparto 13, 14
Esparto, transparency of 152
Example of determination of sizing 125

Fastening the clay with alum 39
Feel imparted to paper by starch 116, 141
Feel of paper 89
from alum 141
pulp 141
related to its size 142
Fibre, appearance of the 49
how distributed in machine papers 99
long; its effect upon paper 49
in Japanese paper 49
Fibres connected by size 108
Filtering paper 187
Finish; connection with sizing 106
of drawing papers 128
printing papers 130
writing papers 129
paper 126, 148
not indicative of quality 126
Finished paper, sorting of 59
Finishing darkens colours 139 *b*
Flour paste in paper, effect of 116
Flow of pulp, regulating the 65
Fluctuations in prices 154
Foolscap 159, 169
Foul smell of tub-sized paper, occasional 121
French grey, fibre in 49, 98
Functions of sizing 106
Fusing resin size 105

Gelatine size 36, 59, 110
Glazed boards 130
Government contracts for stationery 112
Granite paper, wrong side of 156
Grease spots 152
Greyness of cartridge papers 144
Gums and resins in plants 24

Half-stuff 32
Hand 160
Hand- and machine-made papers, comparison of 93
papers, difference in 44
Hand-made paper and linen rags 41
straw 41
colour as a test for 139 *b*
couching of 51
difficulty of determining 137
differently coloured sides 61
drying of 58, 96
felt marks in 54
laid watermarks in 48
pressing of 52
quantity made per day 56
requirements for good 45
retree in 104
rough edges of 139
separating of 55
sizing of 59
Hand-mould, description of 48, 80
Hard-sized papers, effect of printing ink upon 115
Herring, Mr. 88, 96, 100
High finish no indication of quality 126
Hofmann on raw material 5
Hollander 43
Hot pressing 131
Hot rolling machines 135
How fibre sets in machine papers 98
Hydrochloric acid 33
Hyposulphite of soda 33
Hypothetical contraction of royal 100

Identity of laid and wove 79
printings and writings 78
Imparting good feel to paper 116, 141
Imperfections 155
Imperial 165, 169
India rubber 149
proof paper 188
Ink, alkaline paper and printing 88
Ink and paint, insolubility of 24
Ink. printing, on heavily-sized paper 115
Iodide of potassium 122
Iron in paper 88, 149
Ivory cards 189

Japanese copying paper, its strength 49
paper 106
Jute 12

KAOLIN 35

LAID and wove papers, identity of 79
dandy roll 82
hand-mades, no wove mark in 139 *c*
machine-papers, wove mark in 139 *c*
water-marks 48, 80
Large post 169
Layer 53
Length of fibre and its result 43
in thick and thin papers 91
Linen and paper, analogies between 116, 37, 130
fibre, microscopical features of 7
for strength in paper 8
rags 6
rags in hand-made papers 41
Lithographic paper 190
Litmus paper 34
Loading materials, abuses of 84
a source of weakness 92
classes of 35
Loan paper, classification of 76, 191
contraction of 96, 100
Loft-dried paper 58, 111
drying of machine papers 103
London boards 192

MACHINE- and hand-made paper, comparison of 93
Machine- and hand-made paper, differences in 44
Machineman, manipulation of pulp by 150
Machine paper formed on wire cloth 49
possible contraction of 100
rough edges in 139 *a*
setting of fibre in 98
uniformity of 104
Manifold paper 193
Manilla 11
Materials for paper, the requisite 1
in use 3
Medium 169
Metallic paper 194
Methylated spirit 124, 125
Microscopical features of cotton fibre 9
linen fibre 7
Middles 195
Mill finish 128, 133
Milling 134
Mixture of the half stuff 3 *d*
Moisture and its relation to weight 171
Mould for paper 48
shake of the 49

NAMES of papers 157
Natural drying of hand-made paper 96
Neutralisation, how effected 34
importance of 88
Nominal ash 84
Normal ash 84
Number of sheets in a ream 173

ODOUR in paper 83
Oiled royal 196
Orange mineral 37
Origin of wove paper 80
waterlines 80
Oxidation of iron 149

PAPER and linen, analogies between, 37, 116, 130
Paper, division of into classes 76
drying the 74
handles better on cutting 142
mould 48
neutrality of 88
sized and unsized, characteristics of 106
of same name, but different sizes 168
toning of 37
width of; how regulated 69
Paragraph *16*, reference to, 84; *23*, 81; *30*, 88; *32*, 43; *33*, 88; *35*, 84; *36*, 114; *37*, 144; *39*, 141; *42*, 99; *48*, 82; *49*, 96, 104; *59*, 107; *61*, 87, 139 *b*; *70*, 139 *c*; *71*, 139 *c*; *76*, 61; *79*, 81; *81*, 71; *82*, 139 *c*; *84*, 24; *90*, 141, 153; *96*, 49, 98; *98*, 156 *f*; *101*, 98; *104*, 105; *105*, 106; *106*, 75; *113*, 124; *114*, 106; *118*, 123; 119, 124; *122*, 203; *13*, 83; *139*, 156 *e*; *139 b*, 149; *144*, 37; *149*, 139 *b*; *156*, 139 *b*.
Pasteboard 197
Pearl white 35
Persistent tension of machine paper 96
Photographic paper 198
Plant fibre, bleaching of 1
Plants, gums and resins in 24
Plate glazing 132
paper 106, 199
Point at issue in strength 100
Possible contraction in machine papers 103
Post 161 169
Posts always of a writing quality 168
Pott 158 169
Precipitated calcium sulphate 35
Precipitation of resin 39
Preparation of wood pulp 15
Pressing hand-made papers 52
Press rolls 73
Price enhanced by machineman 150
and its fluctuations 154
Printing ink and sized papers 115
papers from cotton rags 8
engine sizing of 114
surfacing of 130
unsized 115
Printings and news paper, clay in 84
writings, identity of 78
Pulp, colouring of 37
dilution of 63
distance it travels 68
imparts good feel 141
regulating the flow of 65
using up fine 80

QUALITY not indicated by finish 126
of laid and wove hand-mades 81
Quantity of paper made by hand in a day 56
Question of strength not influenced by contraction 100

RAGS, boiling of 22, 24
cutting the 19
former preparation of 43
linen 6
number of classes of 17
sorting of 17, 18
their suitability 4
washing of 26
Ream of paper, breaking of 88

Regulating the flow of pulp 65
Regulation of width of paper 69
Relation of strength to weight of paper 91
Raw material for paper 5
Requirements for good hand made paper 45
Requisites in paper material 1
Resemblance of machine-made to hand-made papers 137
Resin Size 36, 78
for printings and cheap writings 114
how it acts 114
precipitation of 39
test for 124
Resin-sized papers, erasures in 105
Resins and gums in plants 24
Retaining the water in the stuff 68
Retention of water by starch 116
Retree in hand-made papers 104
separation of 59, 155
Revolving boilers 15
Right and wrong sides of paper 156
Rolling 135
Ropes 10
Rotation of crops 84
Rough edges of machine papers 139 *(a)*.
vat paper 139 *(a)*.
Roughness no indication of wrong side 156
Royal 164, 169
hypothetical contraction of 100

SHADES of paper, significance of 145
Shake, fore-right 49
Shake of wire cloth 68, 96
Shaking a paper-mould 49, 96
Sheet and half foolscap 169
third foolscap 169
Short pulp, using up 81
Side-shake 68, 96
Separating of hand-made papers 55
Significance of watermarks on quality 82
Silica, dissolving of, from straw 24
Silica in straw 16, 84
Silk and woollen rags, unsuitability of 1
Similarity of sizes 169
Similar names of different sizes 168
Size and its absence, characteristics of 106
connects the fibres 108
and clay 86
of paper related to its feel 142
not indicated by watermarks 166
indicated by watermarks 167
Sizing, difficulties of 105
distinguishing the different kinds of 117
hand-made papers 59
matter 36
tub, animal, engine, resin, starch, soap 109, 110
Small post 169
Smell, foul, of tub-sized paper 121
connection with finish 106
functions of 106
Soap, formation and solubility of 24
Sorting the rags 17
Specific gravity of loading materials 37
colouring matter 61
Specimen 1, reference to 15, 92
2, 49, 80, 98, 156
3, 49, 106
4, 61, 76, 80, 82, 139
Specimen 5, reference to 76, 80, 82
6, 84, 148
7, 84, 148
8, 84
9, 84
10, 128
11, 106
12, 106, 175
13, 106
14, 106, 183
15, 106, 139, 156
16, 106, 199
17, 106
18, 127, 128, 156
19, 130, 148
20, 139, 191
21, 144, 180
22, 174
23, 194
24, 203
25, 139
26, 193
Spirit of wine 124
Stampers 43
Starch fastening the clay 116
in paper, effect of 116, 141
size 36
test for 122
Stationary boilers 25
Straw boards 200
in hand-made papers 41
silica in 16, 24, 84
yield of fibre from 16
Strength of paper 153
comparison of 90
contrivance for determining 90
from linen 6
from long pulp 43
greater in one direction 98
in relation to weight 91
not influenced by contraction 100
real question at issue 100
sacrificed to uniformity 151
theoretical 99
Stuff chest 40
retaining water in 68
Suction boxes 139 *(c)*
Super-calendering 132
royal 169
Supposed inferiority of wove paper 81
Surface on drawing papers 128
printing 130
writing 129

TABLES of breaking points 101
Tannic acid 119
Tearing as a test for vat papers 138
Tests for different kinds of size 117
hand-made papers 139
strength 153
wrong sides of paper 156
Theoretical strength of machine paper 99
Thickened edges of paper 120
Thin and thick papers, length of fibre in 91
Tissue 106, 201
Toned papers, how produced 37
Tracing paper 202

Transparencies due to esparto 152
Trial to produce strong paper 8
Tub sized paper, erasures in 105
sizing 110
by hand 111
Tub sizing by machine 111
tests for 119

ULTRAMARINE 37, 61
and smalts, high specific gravity 61
Unglazed surface, imparting an 134
Uniformity of machine papers 104, 150, 151
Using up short pulp 81
Unsized papers, capillary action of 107
printings 106, 115
value of 115
Unsought watermark 139 *(c)*.

VACUUM boxes 70, 156
139 *(c)*.
Value of paper, fluctuations in 154
unsized printings 115
Varieties of surface 128
Vat 40, 47
Vatman, dexterity of 49
shake of mould by the 49
Vegetable parchment 203

WASHING and breaking engines 44
description of 26, 27, 28
Washing of boiled materials 26
Water marking by dandy roll 71
Water leaf 107
Water lines, origin of 82
their bearing on size 167
Watermarks 156
laid in hand-made paper 48
and their significance of quality 82
Watermarks not indicative of size 166
Water, retaining of, in the stuff 68
retained in pulp by starch 116
Weakness of paper, causes of 92
Weight of linen from raw flax 5
paper in relation to its strength 91
calculation of
determination of 170
Wet end of paper machine 98
Whiteness in paper, how obtained 37, 144
Willow 20, 44
Width of paper regulation of 69
Wire cloth, all paper formed upon a 82
description of 67
mark 156
shake of the 68
side of vat papers 156
Wood-pulp, preparation and strength of 15
Woollen and silk rags, unsuitability of 2
Work necessary to produce a cwt. of pulp 44
Wove and laid paper, identity of 79
wire hand-mould, origin of 80
Wove dandy roll 81
hand-mades, difficulty of detecting 139 *d*
hand-mould 80
paper, suposed inferiority of 81
watermark in all machine papers 139 *c*
Writings and printings, identity of 78
classification of 76
finish of 129
sizing of 110
cheap 114
unsized 115

YELLOW ochre 37
stains in paper 149
wove 76

ZINC plates in hot pressing 132

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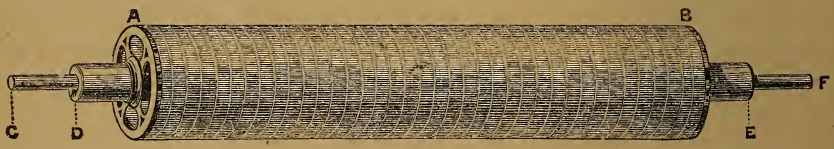

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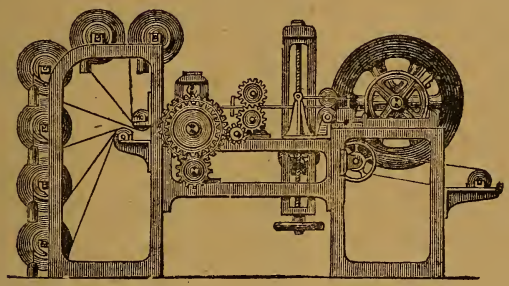

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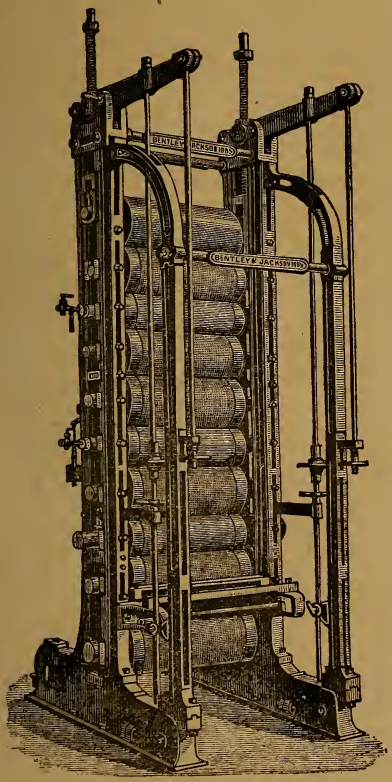

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